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Heating Piping & Air Conditioning

DESIGN
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MAINTENANCE

APRIL * 1944

INDUSTRIAL
COMMERCIAL
AND LARGE
BUILDINGS

223: Journal Section of the American Society of Heating and Ventilating Engineers

Sixty-three specific fuel saving suggestions for heating, piping, and air conditioning systems are given on pp. 183-186

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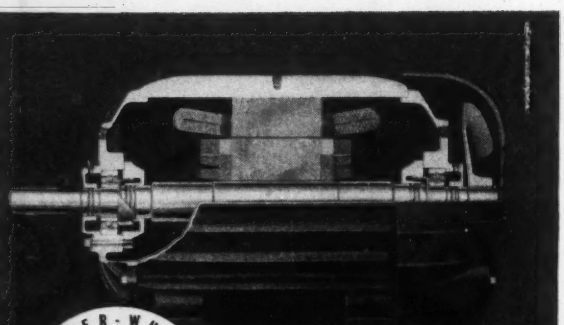
FOR

Sulphur & Sulphuric Acid Handling Plants
Rubber Mills
Cotton Mills & Gins
Lime Kilns
Sugar Refining
Aluminum Plants
Turpentine & Rosin Plants
Tanneries
Drug Manufacturing
Paint & Varnish Plants
Breweries
Ceramics Plants
Food Processing
Fertilizer Handling
Cement Mills
Oil and Fat Recovery
Flour Mills



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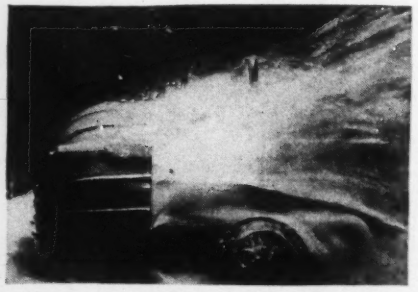

1 **SEALEDPOWER** motor wa placed in tank containing severa inches of water and run continuousl for 8 hours (see photo). It stood idl in water overnight, then was run more hours. During motor's opera tion, the external ventilating fa drenched the outside of the fram with water. At end of test, the moto was disassembled and found to b *completely dry* inside.

2 A dense atmosphere of extremel fine French chalk was kept circulatin around the motor and through i ventilating system for many hours No trace of chalk was found inside upon disassembly.

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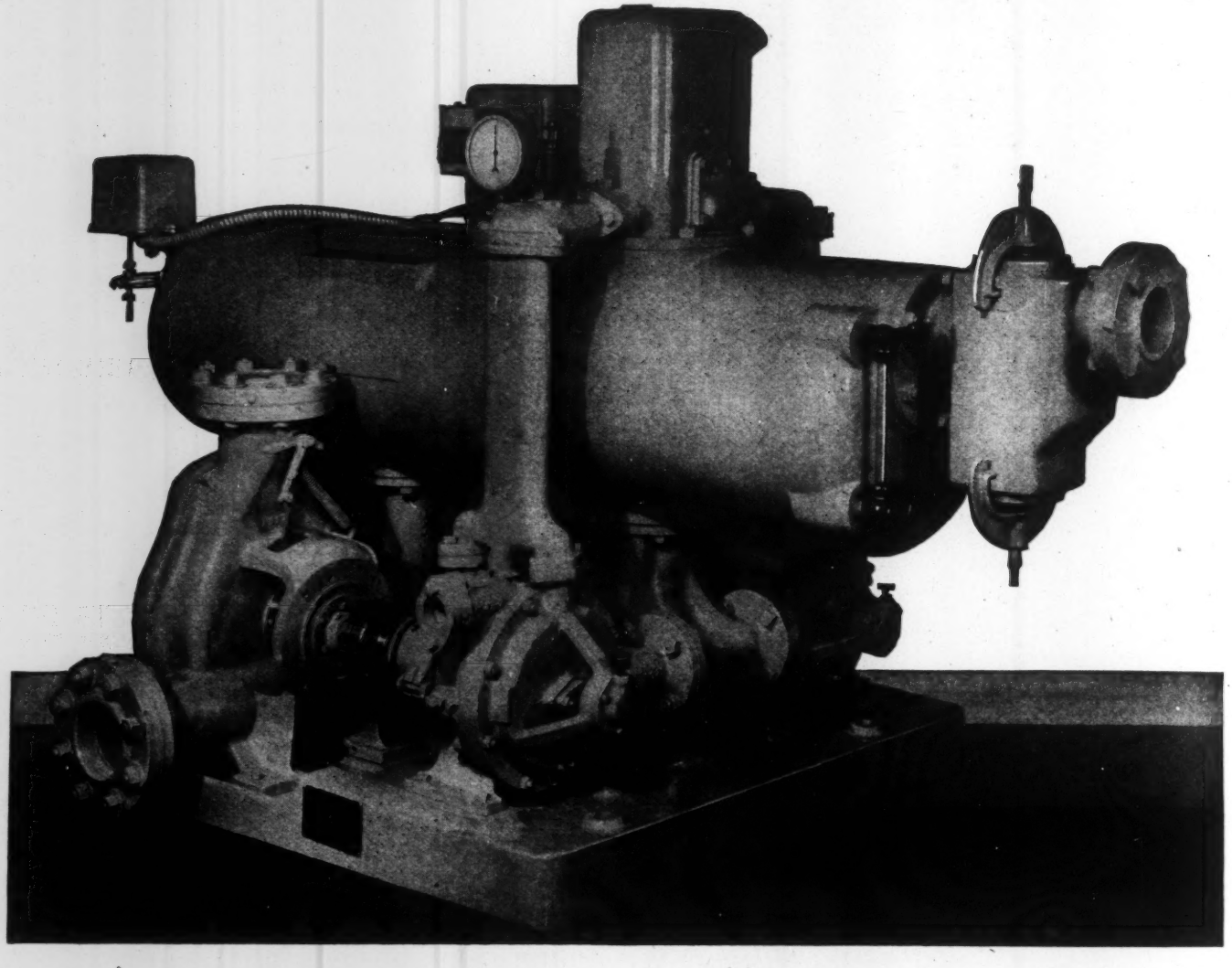
Where Heat Must Not Fail– Install this SAFE Heating Pump!



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THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

Plant bulletin boards tell why coal must be saved, suggest how to do it

63 Ways to Conserve Fuel

Eastman Kodak Fuel Saving Campaign Leads to "Very Gratifying" Results

BECAUSE OF the war, fuel conservation and the efficient use of the energy content of fuels is more important now—and will be of even increased importance in the coming months—than ever before. It behooves all of us to fight fuel waste on every front!

Last winter, the Kodak Park works of the Eastman Kodak Co. inaugurated a fuel saving campaign from which "very gratifying results are being obtained," according to O. V. Sprague, of the power department. For several months there has been "no increase in coal consumption over the same months during the preceding year in spite of a substantial increase in overall plant production and relative heat requirements." While this may not be entirely due to the fuel saving campaign, because of the many factors involved, there is no doubt but the campaign has a large effect, says Mr. Sprague.

An "opening gun" in the Eastman Kodak fuel conservation program was a list of 63 specific suggestions for conserving fuel required for process, heating, lighting, power, refrigeration, air conditioning, water supply, and compressed air services throughout the plant. Through the courtesy of Mr. Sprague, the complete list of suggestions for eliminating waste and conserving fuel needed for these services is presented here. Any plant or building can use this list, with modifications or additions to suit the particular conditions, as a starter in cooperating in the conservation of fuel.

Steam

1) Turn on only amount of steam needed to give required tempera-

The opening gun in a war on fuel waste declared by the Kodak Park works of Eastman Kodak Co. last winter was a list of 63 specific suggestions for eliminating waste and conserving fuel required for the process, heating, lighting, power, refrigeration, air conditioning, water supply, and compressed air services throughout the plant. Usable by any plant or building, with modifications or additions to suit particular conditions, the list of suggestions is given here in full. . . . Fuel conservation and efficient use of coal, oil, gas, and wood become of increasing importance to the nation as World War II approaches its climax.

ture and only long enough in advance to give the required temperature when process is ready to start.

2) Turn on process heat only when needed. Avoid leaving heat on over night or during shutdown when it will be sufficient to turn it on shortly before needed. Turn off process heat promptly when not needed.

3) Turn off steam in rooms or buildings when not in use. Turn off heat instead of opening windows when it is too warm. Sufficient heat should be left on, however, to keep the temperature from going below 40 F so there will be no danger of freeze ups.

4) Avoid unnecessary use of hot water.

5) Shut off ventilating fans and systems when not needed.

6) On large steam consuming equipment, stagger peak loads where possible.

7) Avoid bypassing of traps.

8) In many cases, it will be found advantageous to have some one person in the department, whose duties take him around the whole department, designated to see that all unnecessary steam is turned off at quitting time and to report valves or traps out of order.

9) Have necessary repairs made promptly to insulation, valves, traps, and leaks.

10) Watch for leaks or evidence of leaks, especially valves which allow steam to pass when closed.

11) During shutdown inspect valves, traps, meters, and see that steam is not turned on unless needed.

12) Use 3 psi steam in preference to 70 psi wherever possible because of the lower cost per heat unit.

13) Be sure proper consideration is given to insulation of lines and equipment to prevent radiation losses, especially in air conditioned rooms where extra refrigeration is necessary to counteract the heat given off.

14) Consider automatic control where use of steam is controllable and where savings over hand control or more uniform product will justify the cost.

15) As a rule, use electric motor driven pumps instead of steam siphons or steam driven pumps, because of the greater efficiency.

16) Wherever possible use heating coils instead of steam jets for heating liquids, thus conserving the return water.*

17) Insofar as possible avoid the installation and use of hand controlled interconnections between high and low pressure steam lines as insurance against unnecessary use, or leaky valves.

18) When process conditions change so as to increase the demand or load on steam lines or equipment, have investigation made as to adequacy of existing lines, returns, traps, and equipment. Provision should be made for the return of the condensed water, in all cases where it is usable, and return facilities are available or the quantity involved is large enough to justify facilities, thus avoiding the cost of treating make up water.

19) When extensive changes are made in the process which will change the steam load — either through additional equipment or higher steam consumption in existing equipment—a check should be made by the engineering department.

20) When extensive repairs or replacements are made in steam equipment, alterations or changes from the original layout should be made only with the approval of the engineering department.

21) Consider replacing steam using equipment when there is a possibility of economy through the installation of a more effective type. This will apply especially to the use of recirculation and heat interchanger principles.

22) Special emphasis should be put on the conservation of steam during the winter months when the steam demand is highest.

23) Notify the building engineer as far in advance as possible of any unusually large increase or decrease to be made in consumption, so that he can arrange operation accordingly.

*Careful investigation of the "economics" of this suggestion, balancing all factors involved, would seem to be indicated.—Ed.

Electricity

Lighting

1) Turn off lights when not needed. It is *not* cheaper to burn lights continuously to save wear and tear on switches. This is one of the most common causes of waste of electricity for lighting.

2) Clean reflectors and fixtures.

3) Adequate repairs should be made to switches, cords, and sockets to avoid lights left on because of the inconvenience of turning them off at a broken switch.

4) The amount and type of illumination should be adjusted to the requirements. Where a small amount of light is needed for safety purposes and more intense light is needed occasionally for inspection or working purposes, the minimum light only should be burned continuously and the additional light turned on when needed and turned off when not required. Determine if bulbs are of correct wattage.

5) Locate the work so as to utilize natural light insofar as possible.

6) Protect bulbs against breakage and loss.

7) Replace blackened bulbs.

8) Consider improving lighting conditions when painting.

Power

1) Shut off power when equipment is not in use or not needed, or when satisfactory results can be obtained by starting up shortly before needed instead of being kept on continuously. Examples: Vacuum cleaning systems which are used occasionally. Ventilating

systems not needed over the week-end or while plant is shut down.

2) Keep motors clean.

3) Check belts for slippage and tension.

4) Armature rheostat losses on motors should be eliminated insofar as possible. When a motor is never operated at full speed on the rheostat, an investigation should be made to determine the advisability of changing the pulley or gear ratio, and installing motor of proper speed.

5) Load control. Example: Throttling outlet of fan or centrifugal pump. When the load has been reduced or where for other reasons it is necessary to continuously throttle down on the outlet of a fan or centrifugal pump there is a power loss. In such a case an investigation should be made to determine the advisability of changing to a smaller sized pump or fan or running at a slower speed.

6) Special emphasis should be placed on reducing electrical power consumption during the summer peak load period.

7) Notify the building engineer as far in advance as possible of any unusual large increase or decrease to be made in consumption so that he can arrange operation accordingly.

Refrigeration and Air Conditioning

1) Recirculate conditioned air to greatest extent practicable.

2) Defrost coils promptly. Low return brine temperatures or difficulty in obtaining process temperatures will often indicate too much frost on coils.

3) On water cooling systems watch overflow to avoid unnecessary make up and waste of cooled water. See that the water is distributed uniformly over the cooling coils.

4) Use minimum amount of refrigeration required and use it for minimum length of time required.

5) Watch return brine temperatures and control flow to get required temperature range.

6) Avoid peak loads as much as possible and try to reduce load during peak seasons or periods.

7) In many cases, it will be advisable to have some one person in the department designated to see that coils are defrosted and that valves are maintained at minimum setting to get required refrigeration.

8) Make prompt repairs to insulation, valves, leaking valves in water line or coil used for cooling, leaking valves or leaks in steam lines in air conditioning rooms, and brine leaks. A large brine leak will shut down the whole system unless located very quickly. The building engineer should be notified immediately of any sizable leak.

9) Special emphasis should be put on conserving use of refrigeration during summer when load is heaviest, because the capacity of the equipment is taxed to its limit during the hot, humid days. While coils badly iced up may have sufficient capacity on normal days, they probably will not have when an especially hot day comes along. Be ready for these hot days and do not ask for lower brine temperature at a time when it is most difficult and expensive to manufacture.

10) Notify the building engineer as far in advance as possible of any unusually large increase or decrease to be made in consumption so that he can arrange operation accordingly.

Water

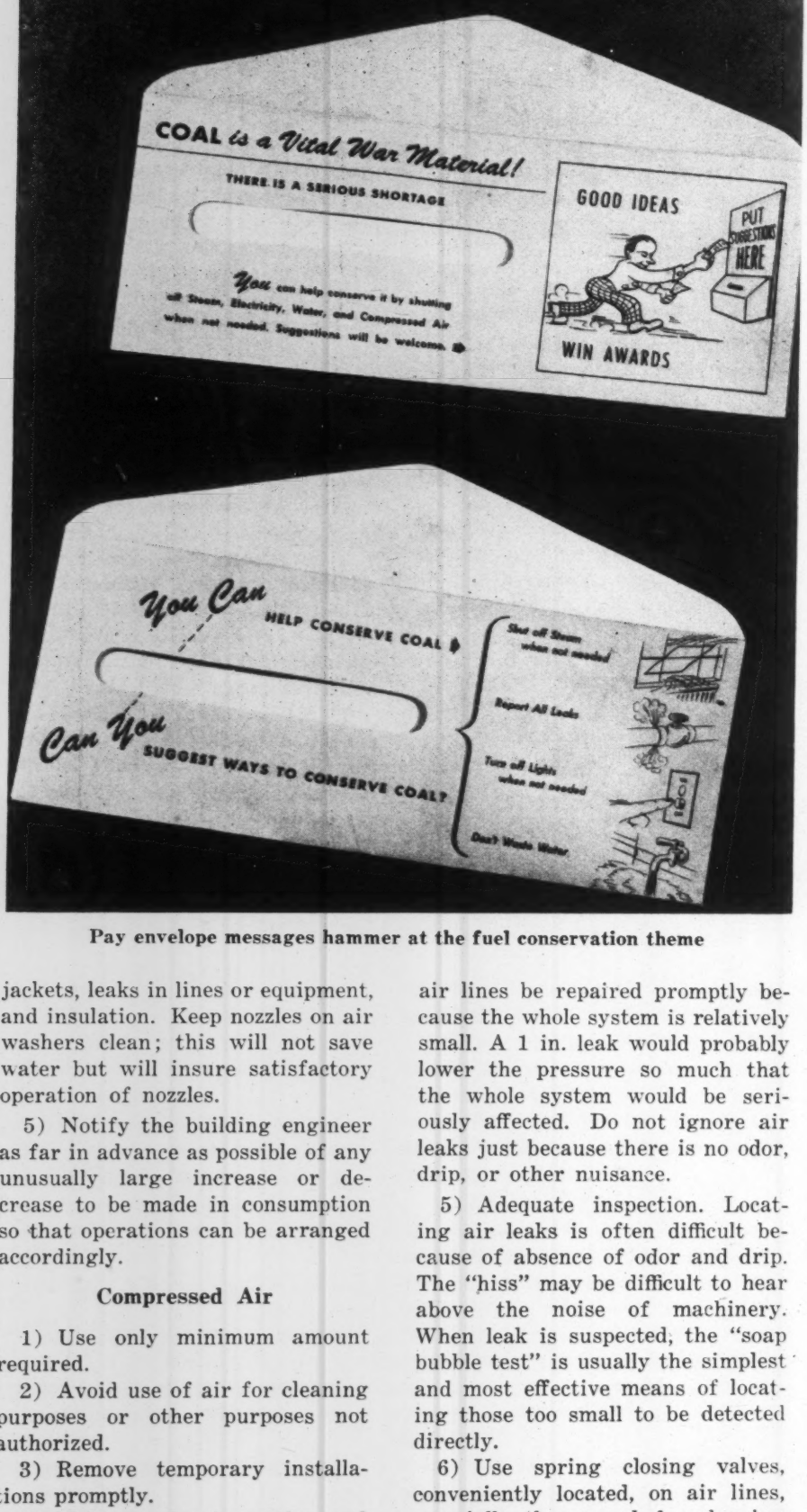
1) Stop all unnecessary uses and waste of water. (Turn off hoses when water is not required.)

2) Keep faucets and outlet valves closed when not needed.

3) Adjust make up water to prevent overflow or keep at minimum required.

4) Make regular inspection and prompt repairs (especially on hot water lines) to float valves (especially on toilets), faucets and valves, packing boxes on water

Workers are reminded daily that coal is a vital war material


COAL is a Vital War Material!
THERE IS A SERIOUS SHORTAGE
You can help conserve it by shutting off Steam, Electricity, Water, and Compressed Air when not needed. Suggestions will be welcome.
GOOD IDEAS
PUT SUGGESTIONS HERE
WIN AWARDS
You Can HELP CONSERVE COAL
Can You SUGGEST WAYS TO CONSERVE COAL?
Shut off Steam when not needed
Report All Leaks
Turn off Lights when not needed
Don't Waste Water

Pay envelope messages hammer at the fuel conservation theme

jackets, leaks in lines or equipment, and insulation. Keep nozzles on air washers clean; this will not save water but will insure satisfactory operation of nozzles.

5) Notify the building engineer as far in advance as possible of any unusually large increase or decrease to be made in consumption so that operations can be arranged accordingly.

Compressed Air

1) Use only minimum amount required.

2) Avoid use of air for cleaning purposes or other purposes not authorized.

3) Remove temporary installations promptly.

4) Make regular inspection and prompt repairs to air lines and equipment, including valves, hose, and connections. It is important that breaks or leaks in compressed air lines be repaired promptly because the whole system is relatively small. A 1 in. leak would probably lower the pressure so much that the whole system would be seriously affected. Do not ignore air leaks just because there is no odor, drip, or other nuisance.

5) Adequate inspection. Locating air leaks is often difficult because of absence of odor and drip. The "hiss" may be difficult to hear above the noise of machinery. When leak is suspected, the "soap bubble test" is usually the simplest and most effective means of locating those too small to be detected directly.

6) Use spring closing valves, conveniently located, on air lines, especially those used for cleaning purposes, and keep them in repair.

7) Compressed air is the highest fuel consuming form of power we have. It should be used as a source of power only when safety, corrosion of equipment, possibility of contamination, or other process requirements make it the most effective service, or where its use may be justified on the basis of occasional use and low installation costs. Such uses as the following are sometimes justified for the above reasons: air jets, air motors, air hoists, agitating liquids, lifting liquids.

8) Be on the alert for possibilities of more efficient air equipment, possibilities of replacing air with other forms of power more suitable or less expensive, and possibilities of replacing high pressure air with blowers or vacuum systems.

9) When process changes are made which materially affect the use of compressed air, check with engineering department.

10) When alterations or repairs are made, do not make changes which will be counter to original layout, without approval from engineering department. Field gang foreman should make sure of such approval.

APPEALS TO USERS TO RETURN AMMONIA CYLINDERS

The acute shortage of steel cylinders for shipping is threatening to bottleneck the flow of ammonia, essential for producing ships, tanks, planes, and weapons, and for refrigerating vital food supplies. Warning that the situation is becoming critical was contained in an appeal last month by the National Ammonia Div. of E. I. du Pont de Nemours & Co. to industrial consumers to empty and return the cylinders in which they receive ammonia promptly.

A company spokesman pointed out that the supply of cylinders is adequate to handle all requirements if they are kept moving between consumer and producer. It is unnecessary for users to maintain large inventories of ammonia stored in the shipping containers, it was said, because every user can be assured of receiving any amount of ammonia he may need within 12 hr after placing his order if the user does his part by emptying and returning cylinders promptly.

SAM LEWIS' PAGE

[In this regular feature, informal comment on heating, piping and air conditioning problems and their solutions is given—at the request of the editors—by Samuel R. Lewis, consulting engineer, and a member of HPAC's board of consulting and contributing editors]

Outside Air Intakes

HORIZONTAL LOUVERS in the outside air intakes to ventilating systems seem to be popular. Perhaps someone thinks that they are beautiful and effective; in truth, they are rarely as effective as promised, since the top and bottom blades are compelled to stop air passage in order to shed water. All louvers must reduce the airway in proportion to their individual height and in proportion to the height of the gross opening through the wall.

Sometimes the louvers are spaced close to each other in order to permit use of relatively shallow blades. As the individual blades in a louver are reduced in width, the top and bottom blades will restrict the airway area to a proportionate extent, permitting reduced height of the opening through the wall. However, with narrow blades they must be more closely spaced to resist entry of rain, and thus can be more easily clogged with leaves or paper. If the air velocity is high, the added frictional resistance becomes serious. An overhanging "eyebrow" or canopy above an otherwise unprotected opening is much to be preferred to any louver. Better yet, if there are projecting eaves at the edge of the roof, the outside air intake opening might be sheltered close under the eaves, with merely a coarse screen to keep out the birds.

When the air intake is on the north side of the building, the entering air in summer may be considerably cooler than if taken from the east or west or south. The entering air generally will be less dusty if taken from high above ground than if it enters near the ground level.

If the intake is above the roof, an effective type of cowl to discourage entry of snow and rain is an elbow looking down at an angle of about 45 deg, called a gooseneck.

Louvers in a wall are equally objectionable when used as outlets for spent air from buildings and goosenecks also, while acceptable as inlets, are condemned as outlets. Any stationary opening into which the wind can blow becomes a funnel when faced to windward and the relatively gentle warm air current coming from an exhaust fan can be nullified—if, indeed, not reversed—by a cold wind of less than gale intensity.

An open-top chimney is the most effective outlet, especially if there is provided an up-sloping finial that will deflect the wind upward so as to induce the air flow from the chimney. Round or rectangular stationary ventilator heads will serve as weatherproof outlets regardless of wind direction and are my choice in case open-top chimneys are impracticable. Watertight drained rain catchers usually can be provided in the attic under ventilators or up-looking air escape hatches.

Electric Strip Heaters

FREQUENTLY ONE encounters in an otherwise satisfactory refrigerated air cooling system, particularly in an office, some unexpected room the occupant of which objects to the temperature of the delivered air. This air may be supplied from a duct that is controlled as to temperature by a thermostat that attempts to suit the average requirements of the majority of the people and which must counteract the effect of solar energy or winds. The exterior conditions may not influence so violently the comfort of the particular person in the room from which the complaint originates.

One such room was an executive's private office situated at the east end of a long trunk duct which served a crowded general office. The private office had excellent barriers against heat loss or gain. If the general office received air cool enough to make the people happy, the executive in his private office was chilled. If the air temperature was increased to satisfy the old gentleman, the people in the general office roasted or stewed.

In another case a room 6 ft square, entirely inside, was built for the telephone switchboard and its beautiful young operator, but the only available air supply for this room came from the general office main, and its temperature was regulated by the demands of the hundreds of people, the large windows, and exposed walls. The switchboard room thus possessed a different heat removal demand from that of the general office, and the occupant felt keenly every sharp adjustment of the air supply temperature necessary to meet the fluctuating general conditions.

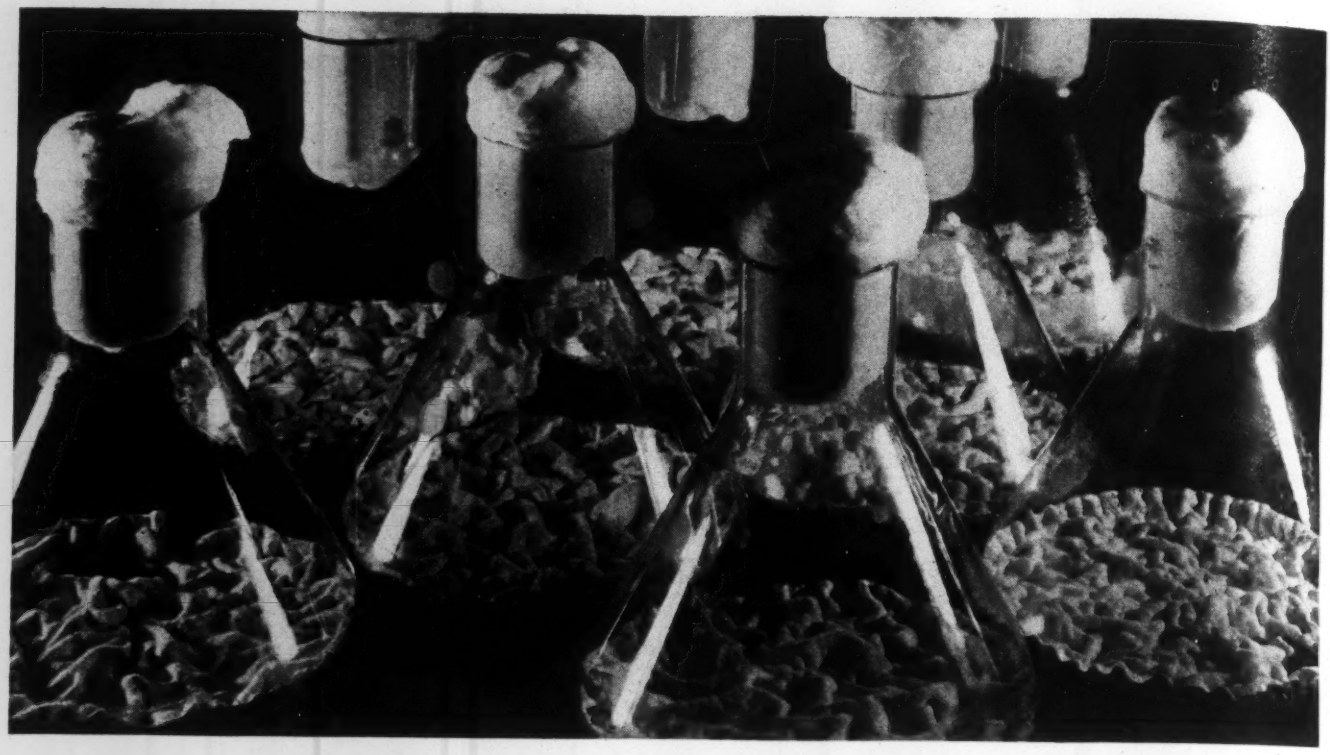
In neither case was steam available in summer, and in both cases, had it been available, the necessary piping and convectors would have been costly to install and almost impossible to conceal. It also developed that the complaints were as justifiable in winter as in summer.

Isolated cases of the sort have been corrected by installing small duct reheaters heated by water from the warm water provided the year around for lavatory purposes. The piping and convectors and pumps for such a service also were impracticable in the cases cited.

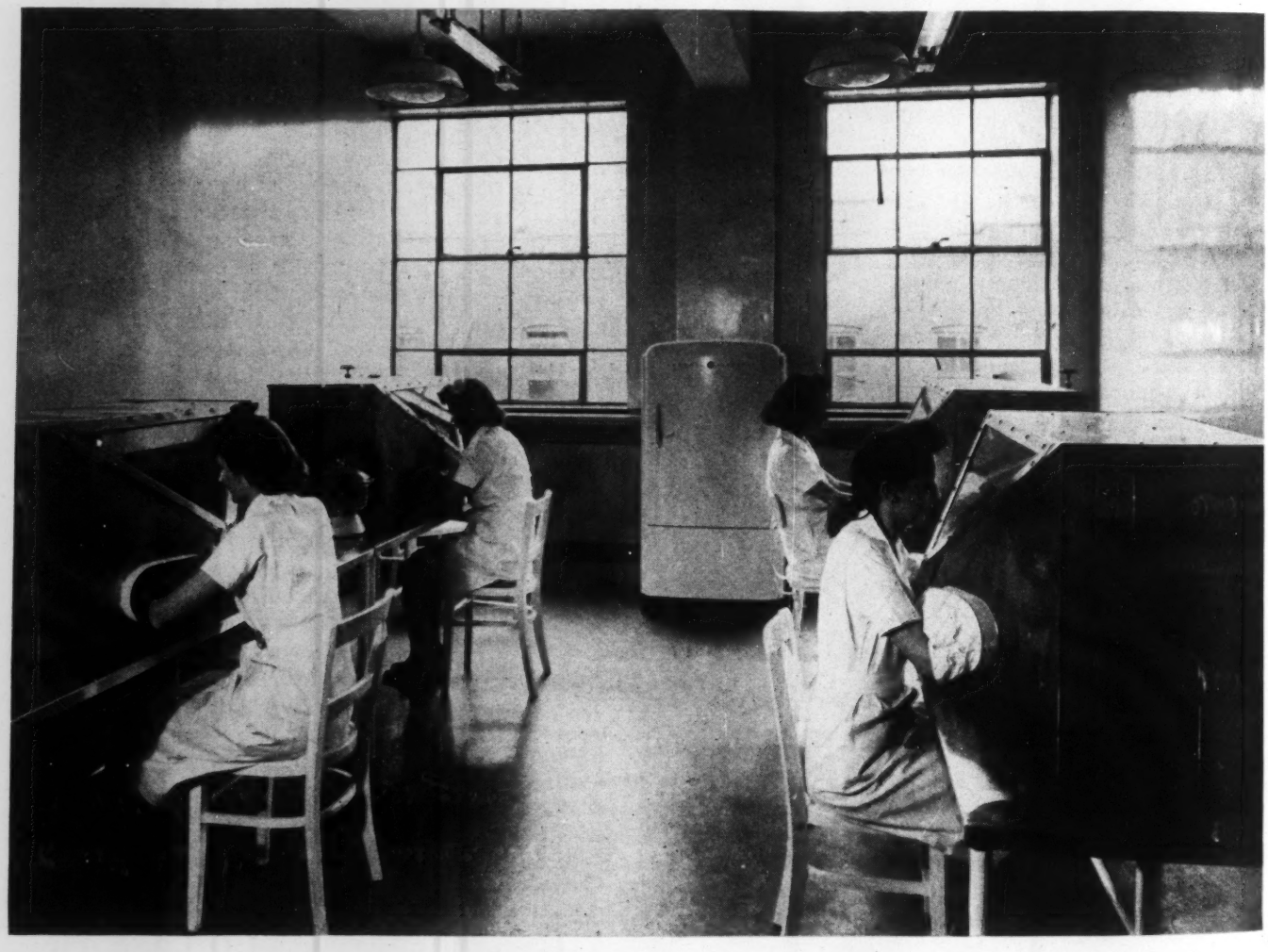
Therefore both corrections were reasonable and economically made by installing electric strip heaters just behind the supply grilles, controlled by thermostats in the air stream.

* * *

● *It is a patriotic duty to save fuel by heating efficiently.*



Flasks containing the mold penicillium, above, and, below, air conditioned weighing cubicles at a plant producing penicillin. Photos here and on p. 191 courtesy Chas. Pfizer & Co.



HOW AIR CONDITIONING SERVES MANKIND

Penicillin Production Depends Upon Control of Air Conditions

Penicillin, the "miracle drug" which is working many wonders in the field of medicine, is another example of a product vital to the wellbeing of mankind which depends to a large extent in the manufacture or growing process upon air conditioning and refrigeration. Intensive research on methods of penicillin production goes forward in plants and laboratories all over the country, and it is impossible to set up any very definite air conditioning standards for the process. It is the purpose here to summarize some of the information on penicillin air conditioning and refrigeration requirements presented by various authorities.

PENICILLIN, THE "miracle drug" which in many ways surpasses those of the sulfa family, is another example of an essential wartime and peacetime product which depends upon refrigeration and air conditioning in the manufacturing process—and thus an example of how air conditioning serves mankind. Intensive research on possible methods of making penicillin synthetically is going forward in plants and laboratories all over the country, for the required amounts are tremendous. No synthetic method has as yet been announced, but much has been done in developing the mold strains and the methods of feeding the mold to increase the amount of penicillin that can be produced.

Because of almost day-to-day developments in penicillin production methods, it is probably impossible for anyone to establish definite "air conditioning standards" for the process. Control of air conditions has been found to be an important consideration in the growth of the mold, and the amount of penicillin produced by a given amount of mold, however. The purpose of this article is to summarize some of the information on the relation of refrigeration and air conditioning to the process, which information has recently been presented.

In a talk on penicillin before the Southern California chapter of the American Society of Heating and Ventilating Engineers, for example, Arthur J. Hess, English & Lauer, Inc., pointed out that molds generally like moist conditions and this mold is no exception. Growing occurs between 70 and 73 F dry bulb temperature, he said; though temperatures can vary from these limits, growth and production slow up materially below and above them. This means that care and ingenuity must be practiced in the design of the air distribution system as well as in the design for a proper volume.

It is a known fact, said Mr. Hess, that when air is introduced into a space its temperature will increase or decrease in accordance with the thermal leakage into the space. And when temperatures must be maintained within the stated tolerances, the design of the system and the temperature control system is a very tricky one. Other conditions make the situation even tougher, he continued. For instance, the growth of penicillin mold is usually made in a series of 2 qt jars partially filled with water which contains the food for the mold. Water will automatically seek the equilibrium temperature of the wet bulb conditions surrounding it; this is accomplished by sensible heat transfer and evaporation. And, of course, in the case of the penicillin, since the mold grows only between the limits of 70 and 73 F, it is necessary to maintain the wet bulb temperature also between these limits.

There is one other problem concerning the design of these systems, he said—the filtration of the air. The mold is a very low form of plant growth and usually exists in a rather fuzzy state so that it can be easily carried through the air. This fact has been known for some time and was determined by breweries who wondered why wild yeast upset their beer formulas regardless of how carefully they controlled the flow of raw materials to the beer producing equipment and regardless of how carefully they controlled the entire process. It was ultimately determined that wild spores of yeast mold were floating around in the air. The same would be true of penicillin mold and wild spores can upset the whole mold strain unless great care is taken. This means very careful filtration of the air. At the present time, strainer types of filters are being utilized. These are filters of the cellulose or felt type which strain the air rather than remove the dirt by impingement on high viscosity oil surfaces.

Probably the ultimate type of air filtration that will be used will be of the electrostatic type, he said. Some research, however, must be made at the present time to see what effects the small amount of ozone created by these filters will have on the growth of the mold.

In another talk given by N. E. Sheldon, of the Carrier Corp., before the central New York section of the American Society of Refrigerating Engineers—and published in Refrigerating Engineering,* the ASRE's journal—it was stated that the mold is grown in a

*January 1944 issue.

rather flat type of bottle, the bottles being racked along the walls of large incubator rooms. A basic culture medium with lactose and various mineral salts and corn steep liquor is then inoculated with a spore suspension produced from the original strain. It is necessary to expose a very large area of the nutrient liquid to the air. The quality of that air is of the greatest importance as any contamination of the air can nullify results. Growth of fungus is established by the first or second day and the growth of mold continues until the ninth or 10th day. Droplets of yellow liquid appear on top of the mold.

The following are a number of principal steps which follow, as outlined by Mr. Sheldon:

1) The yellow liquid is centrifuged from the mold and added to the culture medium. The mixture then goes through three or four steps of chemical extraction with alternate mixing of amyl acetate and the culture medium. Both are cooled to 0 C before mixing.

2) The contracted liquid is made alkaline and mixed with distilled water. The original 20 liters has now been reduced to about ½ of 1 per cent of its original volume.

3) The concentrate is then frozen at about —58 to —76 F and subjected to high vacuum in an evaporating and freezing unit. Several tests are made for strength as the vacuum drying proceeds.

4) At this stage the final product is a small granular powder which crumbles into small grains. It is then placed into ampules of glass which are flame sealed. The packing must be done in very dry air to prevent moisture regain into the powder.

It will take about 20 liters of culture fluid to yield 1 gram of purified penicillin.

The final product is now used only in diluted liquid form. It can be diluted to one part in 2,000,000 parts and still be powerful enough when placed in a culture to kill every germ of certain kinds within 2 to 3 hr. Eventually when production has been greatly increased, it will also be used in powder and salve form.

Where does air conditioning or refrigeration come into the process?, Mr. Sheldon asked, and quoted Dr. C. E. Clifton, bacteriologist at Leland Stanford University, who has stated that the prevention of bacterial contamination appears to be the most difficult, but not insurmountable, obstacle to the production of penicillin on a large scale. An executive of one of the pharmaceutical manufacturers has likened the need of biologically sterile air at optimum temperature and humidity conditions to that of a circulatory system which supports life and growth. Numerous laboratory results have been nullified or rendered inconclusive because of bacterial contamination.

On one installation the air will be initially passed through a good grade of industrial air filter, then through an electrical precipitator, then through an activated carbon deodorizer and gas remover, then through an air washer for fixing the desired dew point temperature and moisture content, and then through sterile lamps before final distribution to the incubation rooms, inoculation room, cooling room, bacteria control laboratory, spore room, drying, shelling and filling room, chemical laboratories, and various other rooms.

A process refrigeration load of about 40 per cent of the tonnage of the air conditioning system is to be handled with 30 F brine to supply chilling effect to the culture medium and amyl acetate.

A small room at —5 F is needed for storage of standards and unlyophiled (before sublimed and dried) liquids.

This all adds up to give a system of air conditioning and refrigeration that is just about the most complete and exacting that design engineers, equipment manufacturers, and installers can produce.

It is a great privilege that men in the air conditioning and refrigeration industry now have in applying their talents to help make quantity production of penicillin a reality, he concluded.

According to a review of penicillin production methods prepared by the Chrysler Airtemp News, more than 41 pints of culture fluid are required to yield approximately ⅓ oz of penicillin. Even this yield is considered high. Two general methods of production are employed experimentally; the "shallow" or "surface" method using flat glass bottles or flasks, and the "submerged" procedure employing large vats of several thousand gallons capacity. In the manufacture of penicillin by the shallow method, a liquid medium is sterilized, sown with spore suspension, and placed in glass flasks or bottles.

The 40 oz bottles which are filled with a liquid consisting of corn syrup and sugar are first sterilized in an autoclave oven at a temperature of 250 F and again sterilized after the bottles are filled. From the oven they are moved to a sterilizing room equipped with lamps mounted on the ceiling. Air conditioning is employed here to keep the room temperature down to 110 F or below, or to a point where technicians can work. Without air conditioning in the sterilizing room temperatures tend to rise to from 180 to 240 F, making it impossible for work to continue.

After sterilization the bottles of liquid are moved into small inoculation rooms measuring approximately 10 ft by 10 ft. Here the bottles are sown with penicillin seed by girls wearing sterile clothing and sterile masks. The small rooms are supplied with sterile air from the adjoining hallway which is equipped with sterilizing lamps in the ceiling and packaged air conditioners to hold a temperature of 72 F. The air is drawn from the hallway through sterile filters into the inoculation rooms by the expedient of maintaining a lower pressure in the small rooms than in the hall.

The bottles are then moved to the "growing rooms" where incubation takes place in from nine to 10 days. Each flask then contains fungus growth and small droplets of a clear amber liquid form on the surface of this fungus. The incubation rooms are held at 72 F by means of air conditioning equipment. The droplets or pearls which form on the fungus are rich in penicillin which must be extracted by an intricate refinement process.

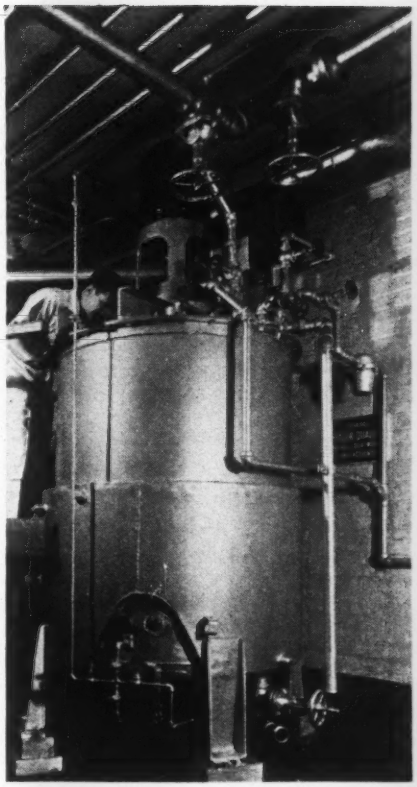
Following the incubation period the bottles are taken to the harvest room where liquid from the bottles is filtered into 100 gal vats made of stainless steel. This room is maintained at 75 F. After certain chem-

icals have been added the liquid is placed in reaction tanks which are held at 40 F by means of a brine cooling refrigeration system.

The bottles are then moved to a separation room which is held at 38 F by means of a refrigeration system and kept sterile by lamps mounted in the ceiling. Here the liquid is packed in ice for shipment at a temperature of 40 F.

Later the liquid is transferred to 2 oz bottles and dried under a vacuum process at —20 F by means of a low temperature refrigeration system. After drying the residue in each bottle consists of a light orange colored powder—the sodium salt of penicillin.

The small amount of powder from each bottle is packed in an ampule, which makes one usable dose of the precious drug. Surgeons working at the fighting fronts have only to add sterile water to the ampule to prepare one dose before intramuscular injection. Rooms where the ampules are packed must be dehumidified to prevent moisture regain in the powder.



Above, pilot plant deep tank fermentation. Below, flask fermentation room

EVEN POSTWAR TRANSITION PREDICTED

We may confidently expect that the level of production and employment in private enterprise will be very much higher during the period of transition after the war than it was in 1940, according to Dr. Harold G. Moulton, president of the Brookings Institution, Washington, D. C., in an address last month.

He summarized the situation by saying that half of the war effort will continue for a considerable part of the period, that foreign relief and rehabilitation requirements will have to be met, that there are large pentup demands for a wide range of consumer products, and that there will be substantial industrial requirements for reconversion and replacement.

Arrearages in Housing

There are vast arrearages in the field of housing, he said, and there will be large purchasing power and abundant credit possibilities.

W. S. Bard, author of this article, has done a great deal of work in applying statistical methods to steam and fuel consumption studies and control, and will be remembered for discussions of the subject published in HPAC in 1937. During the period when the work described in the present article was performed, he was employed in the steam generation and distribution section at a large ordnance plant, and the method he discusses is in daily use at this plant . . . Careful control of fuel and steam consumption for heating plants and buildings is always good business; in wartime, it becomes of increased importance because of the greater necessity for efficient production and operation, conservation of fuels, and because of fuel oil rationing restrictions.

HOW TO WATCH FUEL USE

The Monthly Report

In order to facilitate day to day comparisons of performance and show trends in fuel consumption in the individual units of a plant or building group, a monthly summary form is filled out at the end of each month. This report contains the same information as the daily report described last month, but provides space for totaling and averaging the data.

The nature of the operations carried on at the large ordnance plant where this method of controlling fuel consumption is in use is such that part of an operating unit may be shut down for a period of several months. When this happens it is usual to drain the heating system. This necessitates the drawing of a new curve for the unit. The new curve will be lowered proportionately through all ranges; that is, the percentage drop will be approximately the same through all ranges. Using the previous "normal" curve as a guide, the new curve can generally be located with the data of one month's operations under the new conditions. This treatment is used to draw new curves necessary because of any type of trend, except a trend in nonheating consumption. Such a trend would necessitate raising or lowering of the previous "normal" curve by an equal amount through all ranges.

All such corrections are incorporated in the monthly report, which becomes the permanent record. The actual daily consumption and the "normal" daily consumption for the month are totaled. The difference between these totals is divided by the number of days in the month to find the average daily deviation. This is in turn divided by the "normal" deviation to find the average deviation ratio for the month.

It was mentioned previously that the deviations tend to cancel each other out over a period of time. Over the period of a month the total actual consumption is very close to the total "normal" consumption, the average deviation ratio for a monthly period seldom being over ± 1.0. The average monthly ratios for all units tend to lie close to each other.

If there is a significant upward or downward trend in consumption in any unit this trend will be noticeable when the average monthly deviation ratios for all units are compared (Fig. 1). The median monthly ratio is computed each month. Ratios for units in which it is known that extraneous factors affected consumption are ignored in computing the median. During the basic period 85 per cent of the monthly ratios lie within the range of ± 0.5 of the median ratio. Ratios within this range are considered to be acceptable; ratios outside this range are considered significant and are so noted.

In those units in which consumption is considerably below normal because of a partial suspension of activity or because a conservation effort has been made, the fuel saving can be estimated by computing the difference between the median ratio for the month and the actual monthly ratio for the unit. The ratio for such a unit is not included when the median ratio is computed, and the median ratio is considered to be the most probable value of the monthly ratio for the unit, had not the extraneous factors affected consumption. This difference is then multiplied by the "normal" deviation for the unit to find the average daily fuel saving. This saving can be multiplied by the number of days in the month to find the total monthly saving, which can

then be expressed as a percentage of either the actual or the "normal" consumption for the month. This method of analysis can be applied to measure the importance of any trend, upward or downward.

It is interesting that no trends in consumption were noticeable among the various units when the number of hours of occupancy changed—that is, the same quantities of steam were used to heat the buildings whether the unit was in production for one shift only or for all three shifts, and regardless of the number of occupants on each shift. Only when the unit suspended activities entirely, as on Sundays, was there a noticeable drop in consumption. This suggested another possibility for fuel conservation, the dropping of building temperatures during periods of non-occupancy.

These monthly comparisons of performance would be simpler if monthly consumption were correlated with total monthly degree days. Sufficient data are not available at this time to draw accurate monthly curves of "normal" consumption. Such data as are available indicate that the relationship between fuel consumption and degree days when compared on a monthly basis tends to be more nearly linear than when compared for a shorter standard period. However, the fact that the total number of Sundays and holidays varies from month to month distorts the data; that is, deviations from "normal" will be caused by this irregularity. Correlation based on a weekly period would not be subject to this irregularity but a weekly period is not long enough to allow the deviations to cancel out appreciably. A four week period would be ideal from this standpoint. However, the amount of fuel for heating consumed during such a period is a function not only of the outside temperature but also of the distribution of that temperature during the period, and the deviation for one unit is significant only when compared to the relative deviation in other similar units. The increased accuracy obtained by the use of a four week period does not justify the increased labor involved in collecting the data on this basis, since the effect of the irregularities in the monthly period is the same in all units. A monthly period may be used if the above factors are borne in mind.

An obvious use of the "normal" curves is for estimating future fuel consumption and for routing fuel shipments. Monthly curves are simpler for this purpose. Monthly "normal" degree days can be obtained from the U. S. Weather Bureau. Such estimates will be accurate within the range of error caused by the weather; that is, the probable deviation from "normal" consumption for a month will be less than the probable deviation of the number of degree days from normal. For monthly control the total daily deviations are more accurate.

General Conclusions of Study

In summary, the following are the significant conclusions drawn from this study, as explained in the February and March issues of HPAC, and in the preceding paragraphs:

1) The functional relationship between fuel consumption and degree days when correlated on a daily basis is not linear except in the middle degree day range, from 20 to 40 degree days per day. In the lower range, from 0 to 20 degree days, the curve describing this relationship is concave upward. In the higher range, from 40 to 60 degree days, the curve is concave downward. The curvature of the "normal" curves can be explained by two factors:

a) The tendency of the average efficiency of steam generation to increase during cold weather when the load is heavy and to decrease in mild weather, due to the relative diminishing of overheating during cold weather (in general, building temperatures are lower during cold weather than during mild weather).

b) The fact that the heating system piping delivers heat to the buildings whenever the heating mains are turned on regardless of whether necessary or not, having the effect of raising the curve in the lower degree day range. This also accounts for the fact that the underlying constant load is greater during the heating season than the average nonheating consumption.

2) The absolute size of the deviations of actual consumption from "normal" tends neither to increase nor to decrease with increasing degree days. The range of variation remains relatively constant through all ranges of degree days.

3) The functional relationship between fuel consumption and degree days becomes more nearly

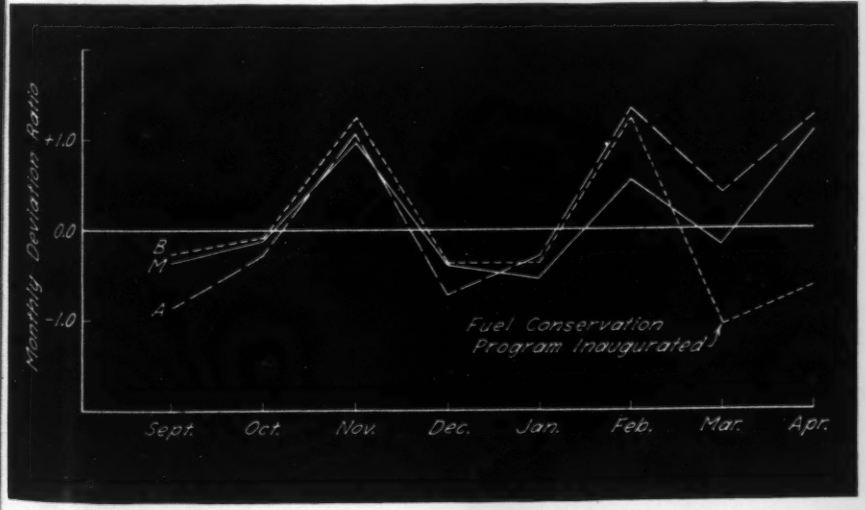
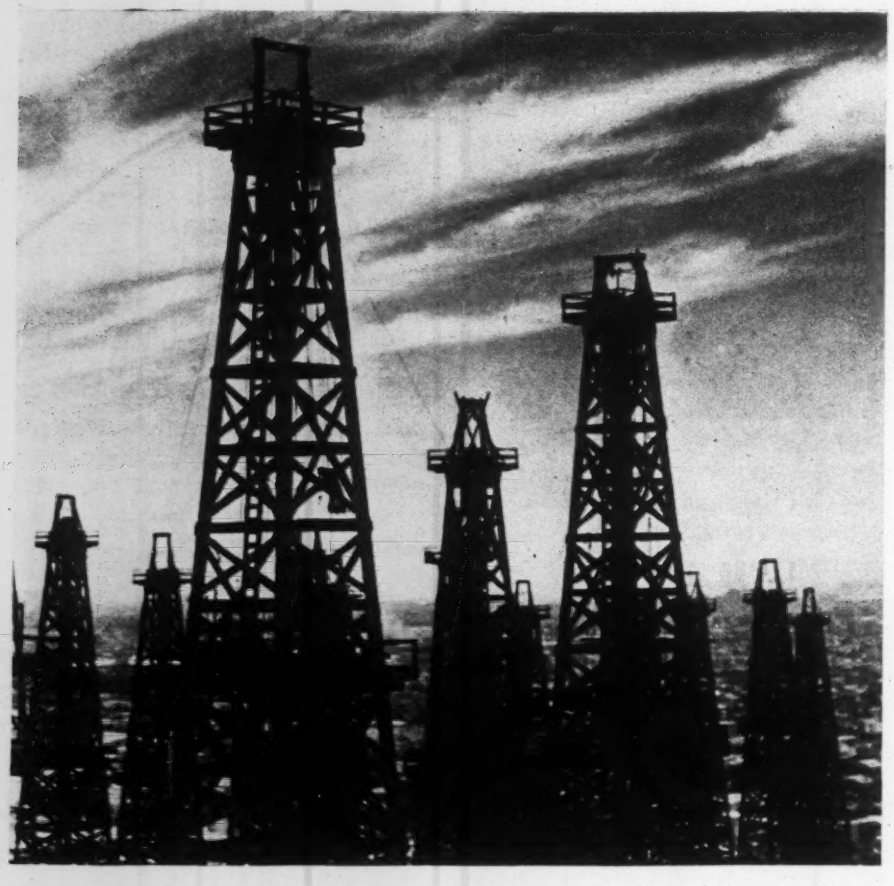


Fig. 1—Comparison of the monthly deviation ratios for two typical units (curves *A* and *B*) with the median monthly deviation ratio (curve *M*). Note that through the month of February the curves for units *A* and *B* lie very close to each other, and close to the median or average curve for all units combined. During March a conservation program was started in unit *B*. The immediate drop in the ratio for this unit—and only this unit—shows the effectiveness of this conservation program



War needs and restrictions place heavy demands on the nation's fuel producing and distributing facilities. Conservation of all fuels—oil, coal, gas, and wood—is thus a wartime necessity and a patriotic duty. In the accompanying article, third of a group of three, the author concludes his explanation of the method of watching fuel oil use at a large ordnance plant; the scheme is applicable to any kind of fuel in any type of plant or building group. In a following article, the conservation program inaugurated at this plant will be described

linear as the comparison period is lengthened; i.e., monthly fuel consumption is more nearly a linear function of monthly degree days than daily fuel consumption is of daily degree days; and the correlation over the longer period is higher—that is, the relative variation of the monthly deviations is not as extreme as the daily deviations, due to the tendency of the daily deviations to cancel each other out over a period of time.

4) The deviations of actual consumption from "normal" were considered to be due primarily to fluctuations in the heating load rather than to fluctuations in the underlying nonheating load (hot water heating, processing uses, and line losses) or fluctuations in the efficiency of steam generation. The evidence supporting this statement is:

a) The magnitude of the deviations from "normal" is related to the magnitude of the fluctuation in outside temperature.

b) The relative size of the deviations for all units as measured by the size of the deviation ratios tends to fluctuate in the same direction at the same time and to remain within a limited range of each other. It is not probable that the nonheating load would fluctuate in corresponding manner in all units.

c) The size of the "normal" deviation is related to the heating load as measured by the slope of the "normal" curve.

d) The "normal" heating deviation is considerably larger than the "normal" nonheating deviation computed from the summer consumption data.

e) The relative size and direction of deviations from "normal" tend to be the same for both feedwater and fuel oil consumption, indicating that variations in efficiency are not an important cause for deviation.

f) The distribution of the deviations about the curves was similar for all units.

5) No significant correlation was found between the variation in wind velocity and variation in the size and direction of deviations from "normal," except on isolated occasions.

6) The fact that the distribution of the deviation ratios is similar for all units and that these ratios tend to lie within a limited range of each other on any given day provide the basis for interpretation of the significance of the ratios. Roughly, 90 per cent of the ratios are smaller than ± 4.0 and 90 per cent of the ratios on any given day lie within the range of ± 1.5 on either side of the median ratio for all units. Any ratio which is greater than ± 4.0 or is outside of the range of ± 1.5 on either side of the median daily ratio is considered to indicate a significant departure from "normal," and is so noted.

7) Inspection of charts comparing the daily fluctuation in degree days with the fluctuation in size and direction of the deviation ratios, and comparisons of daily actual and "normal" consumption, indicated that in general when the temperature of a given day is colder than the preceding day or days the heating load as reflected by the amount of fuel consumed will be less than "normal," and when the temperature of the given day is warmer than the preceding day or days the heating load will be greater than "normal." The heating load for any day is determined not only by the outside temperature for that day but also by the general trend of temperature.

The reason for this was thought to be primarily due to the nature of the heating control in the buildings. Most of these buildings are heated by standing radiation. There is no automatic control of this radiation. The maintenance men and the occupants of the buildings open and close the radiator valves more or less as their feelings may dictate. During cold weather most of the radiators are turned on. When it gets warmer the radiation is not turned off quickly enough, the buildings become overheated, windows and doors are opened, heat is wasted, and excessive consumption results. During mild weather most of the radiators are shut off. When it gets colder the radiation is not

turned on quickly enough, building temperatures drop, doors and windows are closed, and consumption is less than "normal." When the temperature remains fairly stable over a period of several days the fuel consumption remains relatively close to "normal."

Because of this last conclusion it was thought that a saving in fuel might be possible if the amount of radiation turned on were more closely proportioned to the outside temperature. The conservation program which was inaugurated in an attempt to determine what savings could be made will be described in a following issue.

Don't Waste Heat Units by Dumping Them in the Ashpit

(From Scotty-Grams, a bulletin issued to operating personnel of the Chicago Board of Education by John Howatt, chief engineer, and member of HPAC's board of consulting and contributing editors)

AMONG THE heat losses experienced in burning coal there is one known as "loss of fuel through the grate." The refuse from coal is that part that falls into the ashpit and may be unburned or partly burned coal and ash. The unburned portion may comprise from 15 to 50 per cent of the total weight of dry refuse. This loss is classified as one of the "preventable" losses. While it may be theoretically preventable, from a practical standpoint it is impossible to eliminate it entirely. In general, this loss increases with an increase of ash content in coal and is markedly increased when clinker trouble necessitates the use of a slice bar. Improper handling of the fuel bed in either hand fired or stoker fired grates will result in an increased loss of combustible through the grate. Since the ash content of a fuel has a tendency to increase the amount of combustible found in the ashpit, it becomes evident that the purchase of coal should be made under specifications that limit the percentage of ash permissible in the coal.

Grate Area

In designing a boiler to perform under certain load conditions it is necessary to take into account many factors. One of the important factors that will not lend itself to mathematical exactness is the required grate area. Consider a hand fired installation with natural draft. If the grate area were designed for a specific fuel with almost zero ash content, such as petroleum coke, we would be able to use the minimum grate area in order to secure the required evaporation. If, on the other hand, we were designing for a fuel of high ash content, the required grate area would be much larger. Ash content of a fuel is not, of course, the only factor that governs grate area. Allowance must be made in designing a grate to compensate for deposits of clinker and ash that will tend to lower the fuel burning rate as well as the effective area and consequently lower the evaporation rate. While ash may seem to be totally undesirable, it does have some value in acting to insulate the grates from the heat of the fuel bed, thereby preventing burned out grates.

Ash Fusion Temperature

Another factor to be considered in the purchase of coal is the ash fusion temperature. Inasmuch as the chemical makeup of the ash will vary in the same seam of coal, it is not possible to give a fusion point except within certain limits. Most midwestern coals have low fusion temperatures, ranging from 1900 to 2200 F. Clinkers are formed as a result of particles of the ash sticking together or by the melting of the ash itself. Fusing temperature of ash and the temperature which the ash will be subjected to in the furnace are both important factors in the formation of clinkers. This, however, is not the full story, as a coal that may clinker and cause a great deal of trouble in one type of furnace under certain firing conditions may give little or no trouble in another furnace using different firing methods. Efficient management of the fuel bed that reduces to a minimum the mixing of ash with combustible materials will reduce clinker formations. The formation of soft clinkers is not always avoidable, but the tendency of the type of clinker that has the characteristic of growing upon itself and remaining melted while on the grate can have its spread retarded by good management of the fire.

Clinkers

Hard clinker formed by melting of the ash causes less trouble than soft clinker. Hard clinkers are formed when the ash is subjected to a temperature that is too high. This occurs when ash from the grate surface is stirred up and mixed with the hot portions of the fuel bed. Caution should be exercised to avoid creating this condition. Hand firing and underfeed stokers produce most clinkers—chain grate stokers give least trouble from them.

Combustible in Ash

An examination of the ash dump will often give an indication of the care with which the fires are being handled. Ash that tests 2000 Btu per lb contains too much heat value to be thrown away. Partly burned coal and particles of coal locked up inside the clinkers are two main sources of loss to the ashpit. No plant can be efficient in energy conversion unless it burns all of the combustible in the coal.

DEATH OF LOUIS NAROWETZ

Louis Narowetz, founder and chairman of the board of Narowetz Heating & Ventilating Co., air conditioning and ventilation contractors, died March 12 at the age of 77. One of a small group of men who did much to bring recognition to the ventilating and air conditioning industry, he was elected president of the Building Construction Employers' Association in 1935, and retired from active management of his business after serving his three year term of office.

Difficulties with operation usually occur during the in-between seasons

Design and Control of Year 'Round Comfort Air Conditioning Systems

William Goodman Organizes and Discusses Basic Principles in a Systematic Manner

THE AVERAGE air conditioning installation for summer comfort cooling largely ignores the humidity problem. This is true even though a humidistat or other device is frequently installed as an aid to limiting the maximum humidity in the conditioned spaces.

On and Off Operation of Compressor

The simplest kind of a control installation and the one most frequently used for small and even medium sized jobs is one in which the starting and stopping of the compressor is controlled by a thermostat. Obviously, if—as frequently happens—the sensible load is considerably less than the maximum load for which the compressor has been sized, the compressor will run for short intervals and there will be long off periods. Under these conditions, it is quite possible for the latent load to be just as heavy as it was under maximum load conditions when the compressor was running practically all of the time. Obviously, during the periods when the compressor is off, the humidity may (and frequently does) build up to an uncomfortable extent. Furthermore, even though the compressor is shut off, the circulating fan continues to run. Because of the need for ventilation, the air supplied by the fan is a mixture of outdoor and return air. When the compressor is off, the untreated outdoor air delivered to the conditioned space also rapidly increases the relative humidity.

In an effort to limit the humidity, humidistats are frequently installed in parallel with the thermostat. Either the thermostat or the humidistat can control the running of the compressor. This is an unsatisfactory expedient inasmuch as the humidistat is likely to start the compressor only during periods of light sensible load.

As a result, rooms controlled in this fashion are very likely to be over-chilled. True, the dew point temperature has been lowered due to the condensation of moisture on the coil, but also due to the lowering of the dry bulb temperature, the relative humidity may even rise to a point that is higher than the relative humidity at which the humidistat started the compressor. In this case the compressor will run for an indefinite period, and the room will be cold and humid, resulting in the clammy feeling to which so many people rightly object in air conditioned rooms.

Even where the relative humidity can be pulled down to a point where the compressor will be stopped by the humidistat, the compressor is still likely to run for excessively long periods. Except for industrial types of instruments, the humidistats

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frequently used in comfort installations utilize some organic material like hair, animal membrane or wood. Such humidistats depend for their operation upon the change in length of the material with a change in the moisture content of the material. The lag in such materials is often considerable as it takes some time for enough moisture to diffuse into or out of the material to change its length sufficiently to operate the contacts. When the instruments are new and clean, the situation is not quite so unsatisfactory. However, it does not take very long for a thin layer of fine dust or grease to coat the surface of the organic material on the average installation. Such a layer can materially slow up the diffusion of water vapor. Hence, the time lag in the operation of such instruments may be considerable. As a result, a humidistat of this type tends to keep the compressor operating for excessively long periods even in an atmosphere where the relative humidity is dropping.

Wet bulb instruments, although easily cleaned, seldom are. Wicks covered with dirt and clogged with precipitates are no unusual sight. Consequently, the use of a humidistat in parallel with a thermostat for controlling either the operation of the compressor or for controlling the flow of water to a cooling coil or air washer is, in my opinion, an unsatisfactory method for limiting the humidity in a conditioned space.

Reduced Air Volume

Another expedient occasionally resorted to is to control the volume of air supplied to a conditioned space from a thermostat either in the conditioned room or in the return air. In this manner the volume of air flowing over the cooling coil is decreased at light loads and the compressor is kept running for longer periods. However, the decreased volume of air will have very much less moisture absorbing capacity; the amount of moisture that it can pick up in a room is considerably less than the amount that the full volume of air can absorb. This is true even though the temperature of the reduced volume of air leaving the cooling coils is lower than the temperature of the full volume of air. Of course, as the volume of air flowing through a direct expansion coil is decreased, the temperature at which it leaves the coil falls. But the amount of moisture that can be absorbed by an air supply to a room also depends upon the *weight* of the air supplied. Even if the difference between the room and air supply dew point temperatures has been increased at light loads, the decrease in air volume more than offsets this increase. As a result, when the air supply is reduced because of a reduced sensible heat load, the amount of moisture that the air supply can absorb is decreased. Consequently, whenever the air supply is throttled to hold the dry bulb temperature at any given point, the relative humidity in the room will rise if the moisture load is still the same as it was under maximum load conditions—which is frequently likely to be the case.

When the thermostat controls the volume of air supplied to the room, the compressor is, of course, allowed to run until the volume has been reduced to some previously designated low point, when the compressor may be stopped by a switch on the damper. Another method of control uses a suction pressure switch to cut off the compressor when the load has dropped to some previously designated low point as indicated by the low suction pressure.

Many types of control maintain either the temperature of the water entering or leaving a cooling coil or washer at a constant point, or else they utilize a thermostat controlling the water to maintain the temperature of the air supply at a constant point. In this case, when the volume of air flowing through the coil or washer is reduced, the reduction in the moisture absorbing capacity of the air is directly in proportion to the volume. If the sensible heat load is reduced 50 per cent, the volume of air flowing through the coil will be reduced 50 per cent and consequently the amount of moisture that the air can absorb will also be reduced 50 per cent. With such control the relative humidity is likely to be considerably higher during periods of light sensible load than with a control that allows the temperature of the air to fall during periods of light load although, as has previously been stated, this latter type of control still does not produce satisfactory humidities in spite of the low supply temperature.

Usually the air supply is a mixture of return and outdoor air. When the air supply is throttled by the thermostat, the outdoor air supplied for ventilation is reduced along with the return air. Consequently, under conditions of light load, not only is the humidity likely to rise, but odors may make their appearance due to the decrease in the quantity of outdoor air supplied to the conditioned space.

There are, of course, other disadvantages to operating with reduced volume. With practically all types of side wall air supply outlets, a change in air volume affects the distribution of the chilled air in the room. Where the air volume is reduced by means of one of the new

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The basic principles that govern the design and control of year 'round conditioning systems are organized and discussed in a systematic manner in the series of articles of which this is the second. No attempt is made to show a collection of control and equipment arrangements except insofar as they are needed to illustrate the various points discussed. Instead, the methods of accomplishing certain desired results in air conditioning systems and the broad basic principles that govern the applicability of different types of conditioning systems and controls are presented from a refreshingly new viewpoint. Those who are now designing and will be designing comfort air conditioning systems for postwar installation will find this discussion timely and practical, for no matter what the developments of the future, basic principles will always govern. Mr. Goodman is consulting engineer for the Trane Co., and is a member of Heating, Piping & Air Conditioning's board of consulting and contributing editors.

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area reducing dampers immediately behind the air supply outlet, the distribution is not likely to be seriously affected for moderate reductions in air volume. These area dampers do not reduce the velocity of the air issuing from the register. However, where the air volume is throttled at a central point remote from the supply register, the velocity of the air issuing from the register is also reduced. In this case, even a moderate reduction in air volume can frequently have a marked effect on a system in which distribution of air in the room is dependent upon high air velocities.

To overcome the adverse effect on air distribution with a reduction in air volume, a bypass is frequently used around the cooling coil. In this manner the amount of air flowing through the coil can be reduced in accordance with the requirements of a dry bulb thermostat without affecting the total volume of air delivered through the supply register. However, insofar as humidity is concerned, the results obtained are exactly the same as they would be by throttling the total volume of air supplied. In fact, in some systems, the results may occasionally be worse.

For example, in some systems the air flowing to the bypass damper and the direct expansion coil is a mixture of return air and outdoor air. When the bypass damper opens, both return air and untreated outdoor air are delivered to the conditioned room. As a result, the moisture in the outdoor air delivered to the conditioned room increases the moisture load in the room. The effect is exactly the same as if some moisture producing device in the room were started whenever the by-pass opens. As a result, in such systems humidity conditions are likely to be especially poor during periods of light sensible load. When this type of control is used, it is imperative to make sure that only return air is bypassed. However, even under these circumstances, the relative humidity in the conditioned spaces will be no better than the results that could be obtained with straight throttling of the air which, at its best, is not entirely satisfactory.

Light Sensible Loads in Summer

Year 'round comfort air conditioning systems must be so designed that they will maintain satisfactory temperatures and humidities not only under maximum load conditions, but also under the great variety of conditions that occur throughout the year as summer wanes into fall, fall into winter, and winter into spring. The varieties of sensible heat and moisture loads that occur in combination with each other throughout the year are infinitely varied.

If the sensible load should decrease below the maximum for which the system is designed, it is quite possible for the ratio line on the psychrometric chart to swing over to a position like *1-2* of Fig. 2. In this case, to maintain the room in the condition represented by point *1*, the air supply to the room must be in some condition that can be represented by a point like *3* along line *1-2*. However, the air leaving all dehumidifying equipment utilizing either a direct expansion refrigerant or chilled water is very nearly saturated. It is, of course, impossible to dehumidify the air sufficiently without also lowering its dry bulb temperature. Hence, if the air leaves the equipment in a condition represented by a point like *4*, it is obvious that the only way in which air in the condition represented by point *3* can be obtained is by reheating the air.

If the air is not reheated and instead is delivered into the room in the condition represented by point *4*, the relative humidity in the room may climb above the maximum comfort limit of 60 or even 70 per cent. Thus, if the air is flowing into the room in the condition represented by point *4*, the change in its condition is represented by the

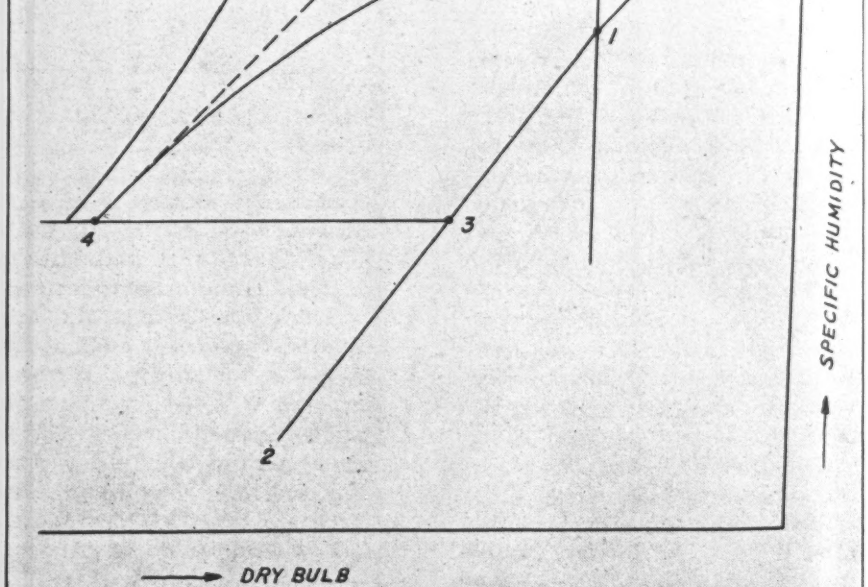


Fig. 2—Skeleton psychrometric chart showing ratio lines for light sensible heat loads in summer. If the air leaves the equipment in a condition represented by a point like *4*, it must be reheated to obtain air in the condition represented by point *3* on chart

ratio line *4-5* parallel to ratio line *1-3*. Thus, if sufficient air is supplied to maintain a constant room dry bulb temperature, the final condition in the room will be represented by point *5* at the intersection of ratio line *4-5* and dry bulb line *1-5*.

In explanation of the foregoing, it should be stated that if the ratio line is drawn through a point like *1* representing the desired condition in the room, all of the other points on the ratio line represent the condition in which the air must be supplied. On the other hand, if the ratio line is drawn through the point representing the condition of the air supply, then the resulting condition in the room will be represented by any point on the ratio line, like point *5* on line *4-5*.

Notice that if the load conditions are such that a steep ratio line results, and the air supply is not reheated, the relative humidity in the room will be considerably higher than the relative humidity at point *1* for which reheated air is required. Frequently, under light load conditions the relative humidity may be high enough to cause uncomfortable perspiration to appear.

Ballrooms, Night Clubs, Etc.

There are many places (such as ballrooms and night clubs) where, even under design conditions, the ratio line is steep, like *1-3* of Fig. 2. In such installations, because of the high latent load, it is impossible to maintain a comfortable combination of temperature and humidity without reheating under maximum load. If no reheating is used in such installations, the relative humidity will be high. The author has seen a magnificently decorated ballroom in which the relative humidity on a recorder climbed steeply to an uncomfortable height during dance periods. In between dance periods, the relative humidity dropped back to normal. In such places, if the dry bulb is maintained at a comfortable point, it will be impossible to maintain a comfortable relative humidity without reheat. The air supply simply cannot absorb enough moisture to hold the relative humidity down. On the other hand, if sufficient air at a low enough temperature to prevent perspiration is supplied, the dry bulb temperature will drop to an uncomfortably chilly point. Also, the relative humidity due to the low temperature will be high even though the dew point temperature is low enough to avoid perspiration in such places. Under these conditions, the atmosphere will be uncomfortably cool—even for dancers.

Theaters, Restaurants, Department Stores, Etc.

On the other hand, places like theaters, restaurants, and department stores can usually operate without reheating under conditions of *maximum load.* However, in such places the moisture load can remain high while the sensible load can decrease. When this happens, the ratio line will swing around to the right to a position like line *1-2* of Fig. 2. How far it swings depends only upon how much the sensible load is decreased —lights may be turned off, the sun may move around to a position where there is no longer any solar gain, etc. Any one of many predictable—and sometimes unpredictable—conditions can arise which lower the sensible gain while the moisture load remains constant. In such places comfortable conditions cannot be maintained without reheating. Again, if the dry bulb temperature is maintained at a comfortable point, the relative humidity rises to the point where perspiration appears. In an attempt to avoid this, the operator frequently runs the plant and tries to produce a compromise condition, which may make matters worse. Running the plant after the dry bulb temperature is satisfied produces the clammy feeling which, unfortunately, is often associated with air conditioning today.

From the foregoing it is quite apparent that it is frequently much more difficult to maintain a desirable temperature and humidity in the conditioned space under light heat loads than it is under the maximum heat load for which the system was designed. In summer air conditioning particularly, a system that will easily maintain a satisfactory temperature and humidity under the maximum load conditions for which it was designed may fail to maintain comfortable conditions under light loads. Furthermore, it is usually more difficult to obtain satisfactory humidities under conditions of light sensible load than under maximum load conditions.

Two Independent Loads Must Be Handled

Designers of air conditioning systems frequently forget that two independent loads must be cared for simultaneously: sensible load, and moisture load. Both the heat and moisture must be absorbed by the air supply if satisfactory conditions are to result in a room. It is true that in comfort cooling the humidity can be allowed to vary through rather wide limits without adverse effects upon the comfort of the occupants. But it is no uncommon thing for the maximum comfortable humidity to be exceeded in an air conditioning system under conditions of light load due to the designer's preoccupation with dry bulb temperature. Although humidity controls are usually provided, such humidity controls are frequently unable to maintain the humidity within desirable limits due to a failure to so design the system that the equipment can maintain the humidity under the control of the humidistat. In this case, the humidistat simply becomes an inoperative adjunct to the system. It cannot *produce* the desired low humidities; it can only *control* the apparatus for producing low humidities.

In-Between Seasons

Maximum load conditions in summer are usually handled quite satisfactorily by most air conditioning systems. The difficulties begin during periods of light sensible loads. Difficulties with operation of the system are more likely to occur during the in-between seasons of spring and fall than at any other time. Many air conditioning systems will maintain excellent conditions all through the winter and during periods of heavy sensible loading during the summer. However, the in-between seasons when the sensible load is light and when the moisture load is as heavy

as it may be during the peak load of the summer will cause difficulties —particularly in buildings where one of the objects of the system is to eliminate the need for opening windows.

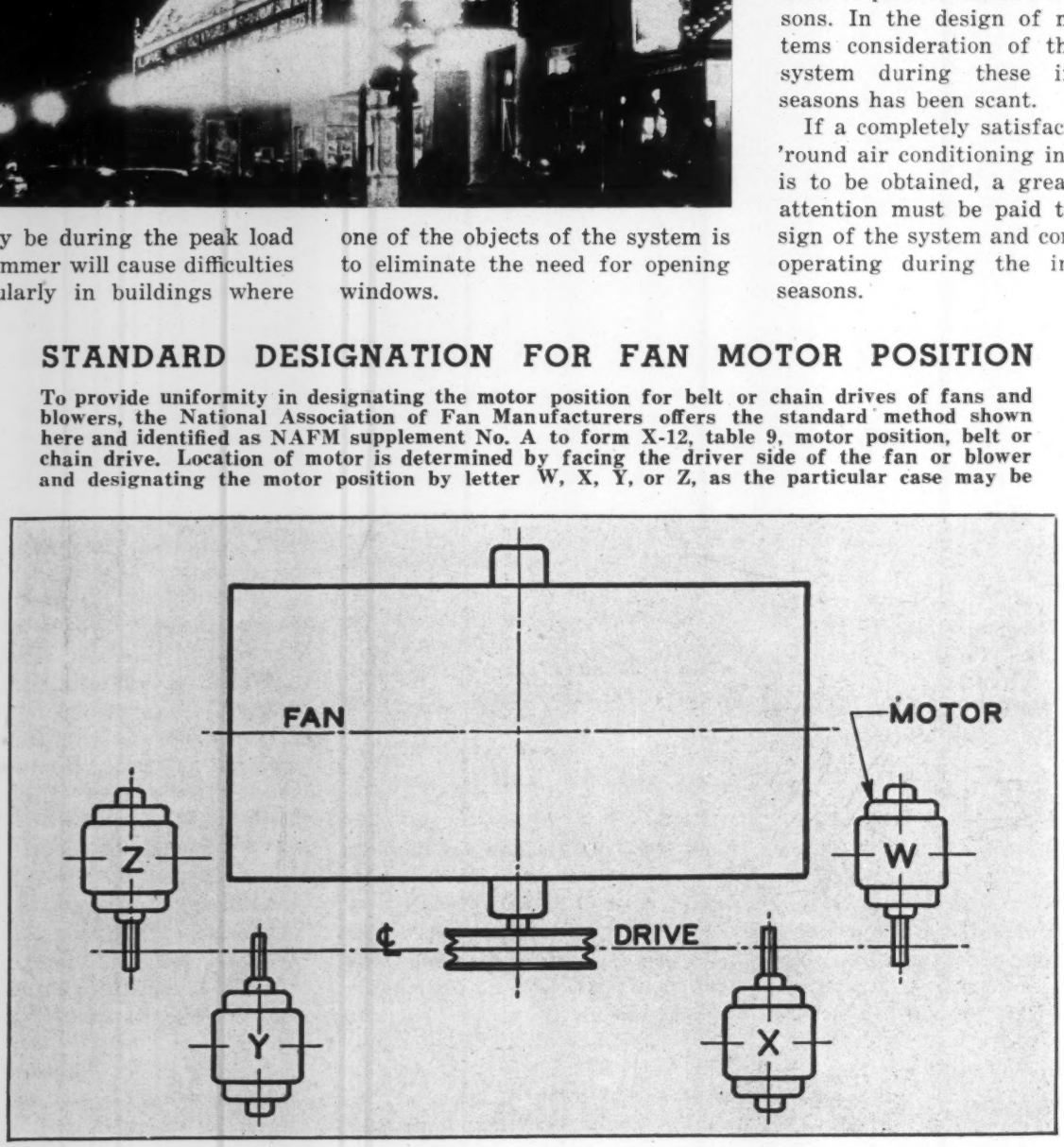
Places like theaters, restaurants, and department stores can usually operate without reheating under conditions of *maximum* load. However, in such places the moisture load can remain high while the sensible load can decrease, and comfortable conditions cannot be maintained under *all* of the conditions encountered.

Most of us are prone to overlook the in-between seasons because they are short. Nevertheless, the period with light sensible load and heavy moisture load is likely to last about a month in spring and a month in fall in the northern part of the United States. A month, twice a year, is quite a long enough period for people to be dissatisfied with atmospheric conditions. Often the feeling in the air conditioning industry has been that if the system operates satisfactorily during the winter and summer, no attention need be paid to the in-between seasons. In the design of many systems consideration of the control system during these in-between seasons has been scant.

If a completely satisfactory year 'round air conditioning installation is to be obtained, a great deal of attention must be paid to the design of the system and controls for operating during the in-between seasons.

STANDARD DESIGNATION FOR FAN MOTOR POSITION

To provide uniformity in designating the motor position for belt or chain drives of fans and blowers, the National Association of Fan Manufacturers offers the standard method shown here and identified as NAFM supplement No. A to form X-12, table 9, motor position, belt or chain drive. Location of motor is determined by facing the driver side of the fan or blower and designating the motor position by letter W, X, Y, or Z, as the particular case may be



A HISTORY of PIPING

M. A. Hasselmann Reviews the Development of Copper and Copper Alloy Piping and Tubing

THE HISTORY of tubing and piping made of copper and many of its alloys dates from the latter part of the 1700's, when improved processes for direct fusion of copper, zinc, and tin were developed in England. Up to that time the methods of working these metals were essentially those used since prehistoric times, and relatively little tubing or piping was made of copper, although some was used in the earliest historic times.

The developments of the latter 1700's led to production in large quantities and at less cost, especially rolled sheets. One evidence of this production was the popularity of brass buttons in England and, after 1800, in the United States. The early brass buttons were punched out by hand from rolled sheet, hitting the simplest hand dies with a hammer. The buttons gave new sparkle to all kinds of clothing, eventually were used on uniforms.

This production of sheet made it practical to manufacture copper and brass tubes and pipes in commercial quantities. Until the early years of the last century, the sheets were cut into strips, the edges bent over to form a lock seam, and the pipe formed. Then the lock seams were pounded tight and sealed with solder of tin, zinc, lead, or a mixture of soft metals. The metal piping found in the pyramid of Tut-Ankh-Amen's father-in-law gives evidence of being made that same way, but from cast sheet of ductile copper alloy metal. After 1800 seams were brazed — fused with brass and without the lock seam. Brazing the seams prevailed until the advent of seamless brass and copper tubing.

Beginnings of American Fabrication of Copper and Its Alloys

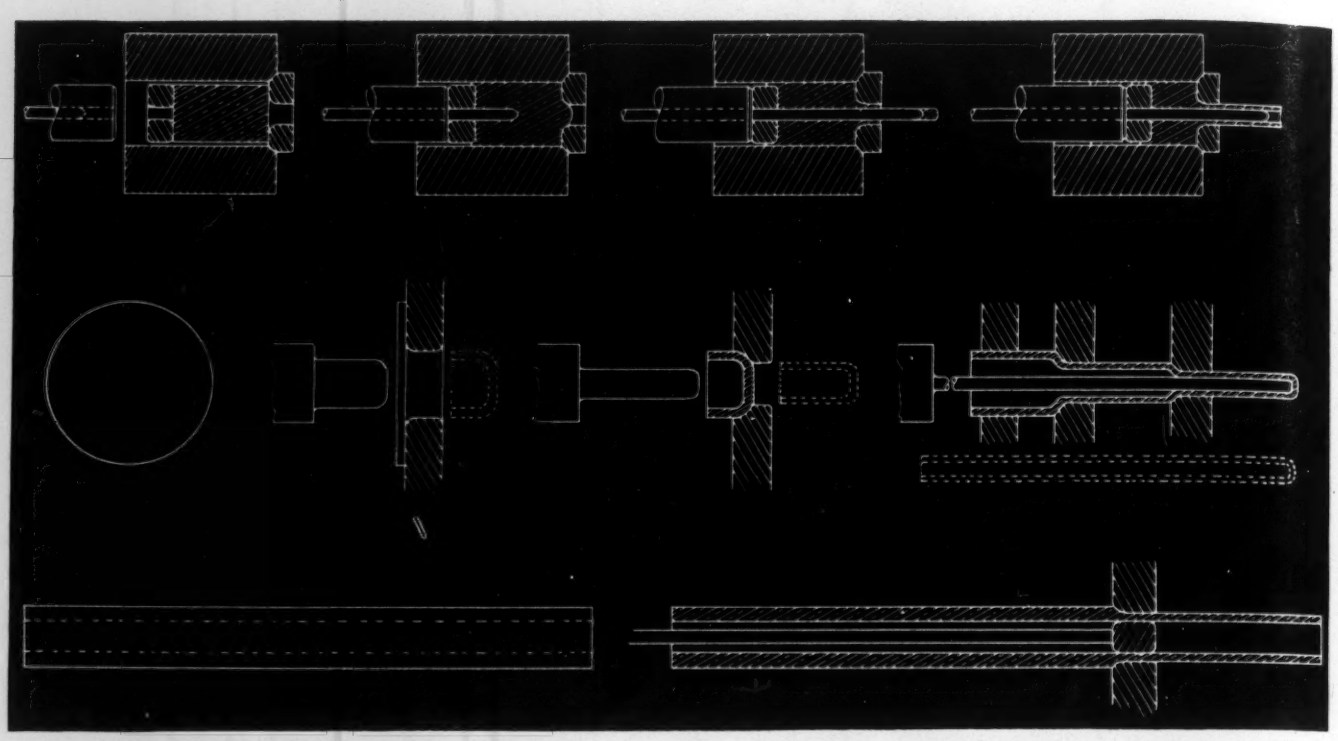
A most interesting thing about the development of the copper and copper alloys fabricating industry in the United States is the way it began in the small valley of the Naugatuck River in Connecticut. The primary reason was the 600 ft drop between the headwaters of the Naugatuck and its junction with the Housatonic 40 miles seaward; every hamlet had abundant waterpower, essential to the rolling of sheet.

Tube was quite unimportant to the manufacturers in the Naugatuck Valley until the latter part of the 1800's. One reason, no doubt, was the preference of the American steam boiler makers and users for ferrous boiler tubes. In England it was a different story for there, as in Europe, boiler tubes were almost always of copper or brass. In 1838 the production of seamless brass and copper tube by the cast cylinder method was begun in England. This process was an extension of a method for making lead pipe. A thick walled, short, hollow brass or copper cylinder was cast and this was drawn through dies to thin walled tube. In 1848 a group of Boston promoters sent a representative to England to get the use of these cast cylinder patents and two years later their company went into production. Other companies followed after the patents expired. This process is still used.

About 1890 patent rights were granted in the United States for the production of seamless pipe by a process in which a hot billet is pierced into a hollow cylinder. The process, applicable to almost any metal that can be worked hot, was first applied by copper alloy fabricators to muntz metal, and is still used extensively in the industry.

The very serviceable copper and copper alloy water pipes we have today did not "just happen" but were the result of constant research, on the part of many companies. Pure copper or an alloy of 85 per cent copper and 15 per cent zinc, commonly referred to as red brass, has proved more resistant to the more corrosive potable waters. Another alloy, with a larger percentage of zinc and known as yellow brass, was also used for mildly corrosive waters. Deoxidized copper SPS pipe has been favored in some localities, particularly the Pittsburgh area. In the decade

This is the seventh of a group of articles on the history of "man's greatest transportation system"—piping—which have been published from time to time in Heating, Piping & Air Conditioning. In these articles, Mr. Hasselmann, of Tube Turns, Inc., has gone back to the beginnings, traced the developments in fabricating processes and methods of making pipe and tube connections, and has pointed out some of the applications of the various materials. The list of materials from which pipe and tube is made is a long and varied one, for the conditions to be met in piping work are many. This month, we consider pipe and tube made of copper and some of its various alloys, from the 1700's to today.



Sketches illustrating methods of manufacture. The top row shows the principle employed in extruding tubing. The second row illustrates the cupping method, showing from left to right the circular plate, first cup, second cup, and drawing out the second cup. Principle of the cast cylinder method is illustrated in the third row, showing from left to right the casing, and drawing through die and over mandrel

preceding Pearl Harbor, thin walled copper tube, with flared and solder type fittings, was making large advances and, doubtless, will continue to do so.

In 1909, the cupping process for making condenser tubes was applied to copper and copper alloys. Cupping, also called "drawn cup," consists of cutting rolled sheets into discs, cupping the discs into a shell, and drawing the shell into a tube.

In 1932 the first extrusion press was set up in this country for the production of tube blanks. Present day presses involve pressures running as high as 3000 tons and more. Up to the present time the extrusion process has been applied mainly to condenser tubes.

In recent years arc welding has been used in fabricating the larger sizes of copper and brass piping. Sheet is curved and joined with arc welded seams. The method has the additional advantage in that fittings can be fabricated and welded of the same material as the piping itself. Such piping usually has van stone type flanged connections. Welding fittings of copper and copper alloys have become common during recent years.

Duplex tube, with a copper or brass lining and steel exterior, or vice versa, is available for various applications.

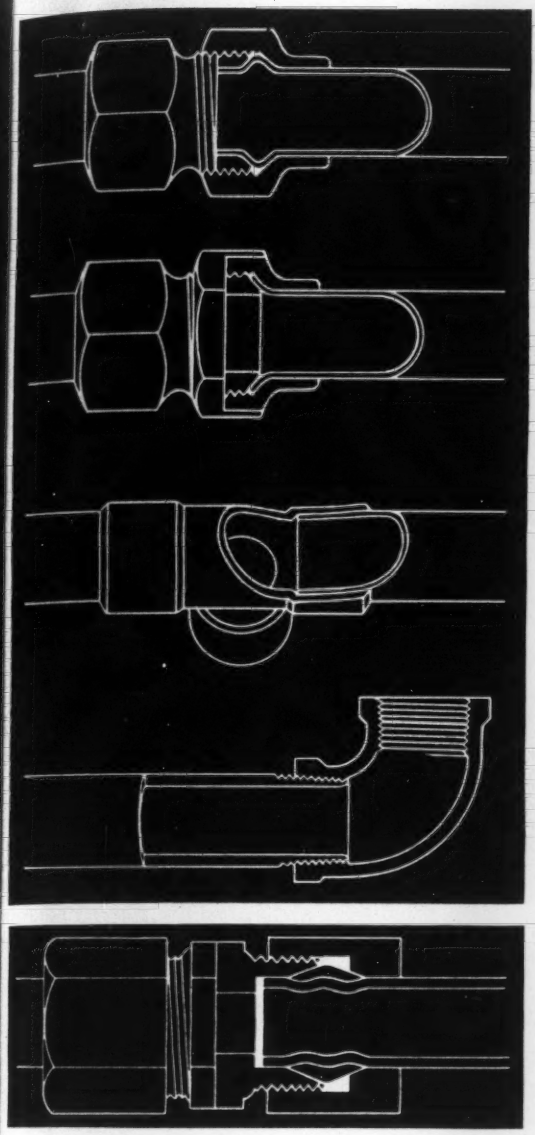
Connections and Fittings

Because the commonly used copper tubings are the small sizes and usually flexible, they are coiled as made and carried to the job in coils. Consequently straight line connections between sections are infrequent. Connections to fittings have been made, since the early 1800's, with flanges or by threading.

However, as seams were improved or eliminated and as applications permitted thinner and thinner walls, a connection for copper and brass tubes other than threading had to be devised. The New England or plumber's fine thread and the wrapped thread were only stopgaps and not satisfactory. One answer was the flared end coupling, developed simultaneously in Scotland and Germany toward the end of the last century and appearing in the United States soon after the turn of the present century. The female nut was slipped over the tube, after which the tube was flared with a cone shaped tool. The face of the other part of the fitting was cone shaped. Squeezed between the surfaces of the two parts of the fitting, the flared end of the soft metal tubing made a very good connection. A second type of fitting for small copper or brass tubing, the loose sleeve fitting, was developed in 1908.

The compression type fitting, used on small copper tubing, is an extension of the flared end coupling and is quite recent. A V-shaped flare is put in the tube an inch or so from its end, and the female nut holds against this ridge.

Within the last 10 years a most significant development in connections for brass and copper tube has taken place, the solder type fitting of cast bronze or wrought copper. The first patent on this type of fitting, also called the "sweated" fitting, was granted in 1930. Instead of being threaded, these fittings are made with accurately-sized openings into which unthreaded, accurately-sized tubings are fitted. The fitted-together parts are then heated to a soldering temperature and the solder applied, either through a hole in



Copper and brass pipe and tubing connections. From top to bottom are shown the compression type fitting, the flared end fitting, the soldered fitting, the threaded, and a plain end tube fitting

the fitting or at the edge of the joining surfaces. The solder flows into the connections by capillary action, making pressure tight, vibration proof joints.

In one development of solder fittings, a groove is formed around the inside of the pipe contacting area of the fitting and a ring of silver brazing alloy fitted into this groove. When the fitting is heated the solder melts and permeates the connection.

Applications

Brazed seam copper tubing was used for a few of the very earliest stationary and locomotive boilers built in the United States or imported and used here—including the first locomotive used in America, given a test run in 1829. The earliest known installation of brass piping in this country is that of a brass gas line installed in New York City in 1836. The first use of brass for piping in buildings was that of water lines in the Old Parker House in Boston, in 1854. The development of industry in general, and of the chemical, sugar, paper, brewing and distilling industries in particular, governed the comparatively small production of copper and brass tubing and piping until the turn of this century. Since 1900 use of copper and brass pipe and tube in plants and buildings, automobiles, refrigerating equipment, air conditioning and heating systems, ships and aircraft has accounted for a major part of the increases in copper and copper alloy pipe and tube production in America.

[Of considerable assistance in the writing of this article was factual material given the author by Charles B. Jacobs, Jr., American Brass Co.; W. R. Webster, Bridgeport Brass Co.; and E. H. Davis, Scovill Mfg. Co.]

ASTM COMMITTEES DEVELOP SPECIFICATIONS

In attendance at the 148 technical committee meetings held during the 1944 committee week of the American Society for Testing Materials in Cincinnati, February 28 through March 4, were 745 materials engineers and technologists, this figure being almost double that of the previous year; the registration figure varies depending upon the number of standing committees which participate in the group meetings. Decision by the ASTM executive committee to issue its widely used Book of Standards in 1944 instead of 1945, the normal triennial year, led many of the committees to meet this year in March to get their specifications and other work as up-to-date as possible. Decision to advance publication by one year is caused by the unprecedented demand for the book.

At meetings of committee A-1 on steel and several of its subcommittees, detailed consideration was given to many of the 130 specifications in the charge of this group.

There was, as usual, considerable activity in the field of pipe and tubing with provisions being established in the widely used pipe specifications A 53 permitting purchase of electric resistance welded pipe in ⅛ in. and ¼ in. sizes. No tensile requirements would be required. There would be limitations on carbon and other provisions would be met.

In cooperation with committee A-10 on iron-chromium and related alloys, a joint subcommittee has been reviewing proposed specifications for corrosion resisting pressure *tubing* for service in cracking stills, dairy and food industries, and for general purpose use, the latter involving both the austenitic and ferritic grades. Another problem is to bring existing chemical requirements on stainless steel *pipe* in line with the current supply situation and this problem was referred to the joint subcommittee.

Because of the disproportionate "necking down" of the 8 in. specimens used in determining tensile properties of certain alloy steel plates for use in boilers and pressure vessels, difficulty has been obtained in certain provisions. As a result, changes are in process which would provide that for plates ⅜ to ¾ in. thick if the percentage of elongation of an 8 in. gage length test specimen falls not more than 3 per cent below the amount prescribed, the elongation shall be considered satisfactory if percentage in 2 in. across the break is not less than 30. This provision will take care of the decrease in percentage of elongation which results as the gage length is increased.

BUY AND KEEP WAR BONDS

Four basic types of manometers are discussed here by R. E. Gould, manager of the war products training service, Frigidaire Division, General Motors Corp., who points out the applications of each to problems met with by test and other engineers engaged in heating, piping, or air conditioning work. The first type considered gives a direct reading of pressure differential in feet of the fluid flowing, the second is a diminishing manometer used when the differential to be measured is large, the third is an enlarging type used when the differential to be measured is small, and the fourth is a type using two fluids different from the one being measured and where the pressure differential which is to be measured is small.

HOW TO USE MANOMETERS

to measure pressure difference

By . . . . . R. E. Gould

TEST ENGINEERS and others are often confronted with the problem of determining the differences in static pressure between two locations in a fluid circulating system. A manometer may provide the means for making such a measurement. However, the selection of the type of manometer is important because the very feasibility of using a specific manometer depends upon the magnitude of the pressure differential to be measured. Furthermore, the selection of the type of manometer for a job should be influenced by the degree of accuracy which is required in the data. Obviously, a sensitive manometer is valueless when applied to a system with violently fluctuating pressures, and likewise to use a very "coarse" manometer to measure a small pressure difference gives rise to considerable inaccuracy. In the following presentation various basic types of manometers are discussed, and a brief theory of operation of each is given so that data or readings may be properly interpreted.

While the instruments available commercially cover many types and variations, only four basic ones will be discussed:

1) This type is very simple in that it provides a direct reading of pressure differential in a flowing system in feet of fluid flowing.

2) In cases where the pressure differential to be measured is so *large* that a direct reading manometer of the type mentioned under (1) would have to be so large as to be cumbersome, a diminishing manometer using an additional fluid may be used. Mercury is commonly used as the additional fluid.

3) In cases where the pressure differential to be measured is *small* so that a direct reading manometer would give only a small, inaccurate reading, an enlarging manometer using an additional fluid may be used.

4) There are some instances where small pressure differentials must be measured, and considering the particular fluid flowing it may be advantageous to be able to select two other fluids to be used in the manometer to secure the desired magnifying qualities.

Direct Reading Manometer

The static pressure at any location in a circulating system may be expressed in many ways, such as in pounds per square inch (psi), or in feet of fluid flowing. The latter may be readily converted to the former if desired by using the equation

$$H_x = p\left(\frac{144}{62.4\ S_x}\right)$$

in which H_x = pressure, ft of fluid X; p = pressure, psi; S_x = specific gravity of fluid X flowing from M to N (see Fig. 1).

Basically a manometer measures pressure in feet of fluid flowing in the system. Thus with the simple, direct reading manometer shown in Fig. 1 the static pressure difference between locations M and N is read directly in feet of fluid flowing as

$$H_m - H_n = d$$

in which H_m = static pressure at M, ft of fluid flowing; H_n = static pressure at N, ft of fluid flowing; d = manometer reading, ft.

This disregards a very slight error due to the difference in weight of the two air columns on each side of the plane RR.

Diminishing Manometer

If the differential pressure is large, the type of manometer shown in Fig. 2 should be used. Assuming that the manometer system is in equilibrium, the static pressure to the left of plane *RR* in Fig. 2 is equal to that on the right. This may be expressed as

$$H_m + e + d + f\left(\frac{S_y}{S_x}\right) = H_n + e + (d + f)\left(\frac{S_y}{S_x}\right)$$

in which H_m = static pressure at *M*, ft of fluid flowing; e = distance indicated in Fig. 2, ft; d = manometer reading in Fig. 2, ft; f = distance indicated in Fig. 2, ft; S_y = specific gravity of manometer fluid *Y*; S_x = specific gravity of fluid flowing from *M* to *N*; H_n = static pressure at *N*, ft of fluid flowing.

This equation simplifies to

$$H_m - H_n = d\left(\frac{S_y - S_x}{S_x}\right)$$

Thus it may be noted that for a large pressure differential, a relatively small manometer reading d may be obtained by selecting a manometer fluid *Y* which is much heavier than the fluid *X*. Of course, the two fluids should not be soluble with each other.

Enlarging Manometer

If the differential pressure is small, the type of manometer shown in Fig. 3 should be used. Again assuming that the manometer system is in equilibrium, the static pressure to the left of plane *RR* in Fig. 3 is equal to that on the right. This may be expressed as

$$H_m + e - d - g\left(\frac{S_y}{S_x}\right) = H_n + e - (d + g)\left(\frac{S_y}{S_x}\right)$$

in which H_m = static pressure at *M*, ft of fluid flowing; e = distance indicated in Fig. 3, ft; d = manometer reading in Fig. 3, ft; g = distance indicated in Fig. 3, ft; S_y = specific gravity of manometer fluid *Y*; S_x = specific gravity of fluid flowing from *M* to *N*; H_n = static pressure at *N*, ft of fluid flowing.

This equation simplifies to

$$H_m - H_n = d\left(\frac{S_x - S_y}{S_x}\right)$$

Thus for a small pressure differential, a relatively large manometer reading d may be obtained by selecting a manometer fluid *Y* which is just a little lighter in weight than the fluid *X*. Again the fluids should be insoluble in each other so that definite separation levels will be visible.

Use of Two Fluids Different from Fluid Flowing

One may find in attempting to use an enlarging type manometer for magnifying a reading that it is impossible to select a manometer fluid which, while being insoluble with the fluid flowing, is also very nearly the same specific gravity. It may be possible, though, to select two manometer fluids which would both be insoluble with the fluid flowing, and which would be very nearly equal to each other in specific gravity. The use of two such fluids in a manometer such as shown in Fig. 4 will give a magnifying or multiplying effect on the manometer reading. Physically it is desirable to have

$$S_x > S_y > S_z$$

in which S_x = specific gravity of fluid *X* flowing from *M* to *N*; S_y = specific gravity of manometer fluid *Y*; S_z = specific gravity of manometer fluid *Z*.

In operation, for any single condition of flow in the system, the amount of manometer fluid *Y* is varied by introducing or withdrawing from the reservoir *K* until the points *U* and *V* are on the same level. The increment d indicated in Fig. 4 is then recorded as the pressure differential reading.

Assuming that the system is in equilibrium, the static pressure to the left of the plane *RR* in Fig. 4 is equal to that on the right. This may be expressed as

$$H_m + e - d\left(\frac{S_y}{S_x}\right) - g\left(\frac{S_z}{S_x}\right)$$

Fig. 1—This type is very simple in that it provides a direct reading of pressure differential in feet of the fluid flowing

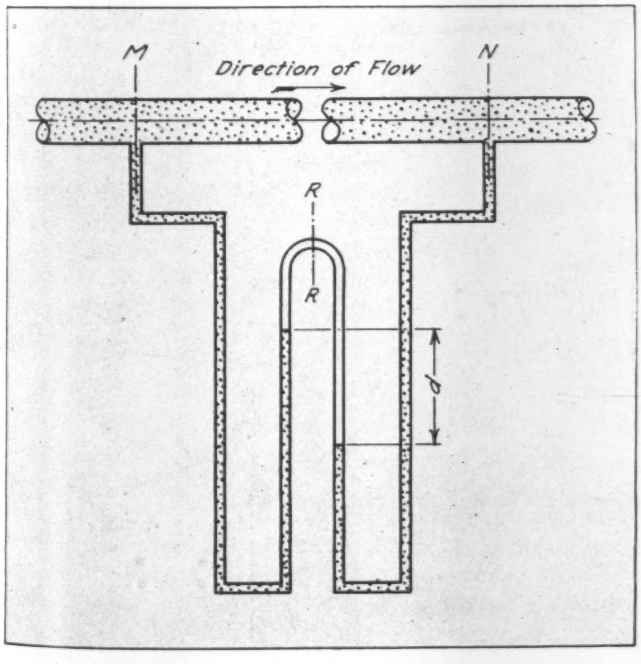
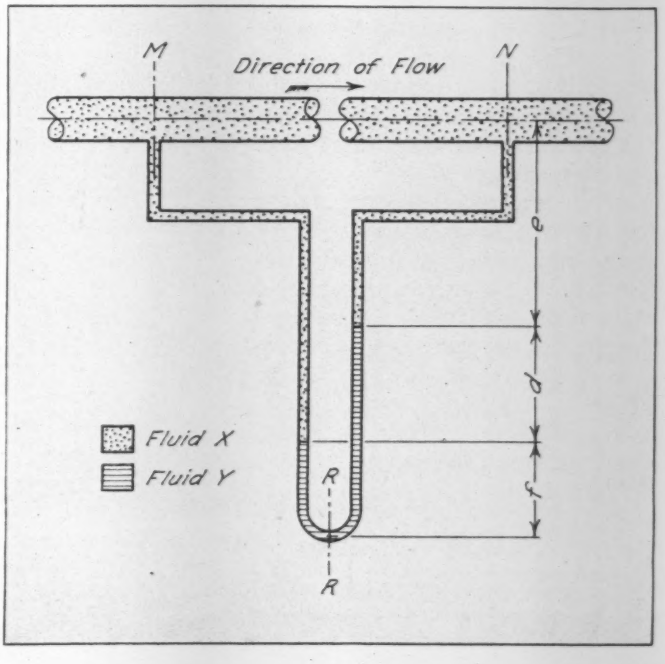


Fig. 2—In cases where the pressure differential to be measured is so large that the direct reading manometer of Fig. 1 would have to be so large as to be cumbersome, a diminishing manometer using an additional fluid may be used. Mercury is commonly used as the additional fluid



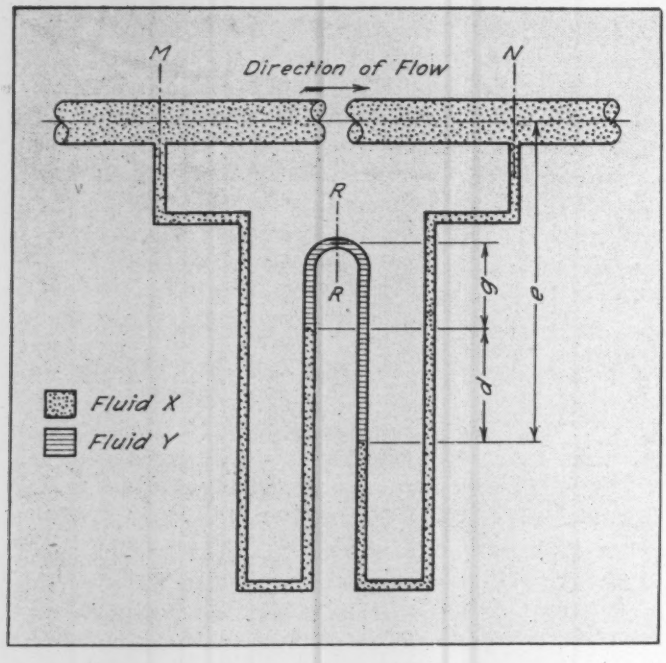


Fig. 3—In cases where the pressure differential to be measured is small so that a direct reading manometer would give only a small, inaccurate reading, an enlarging manometer, as illustrated, using an additional fluid may be used

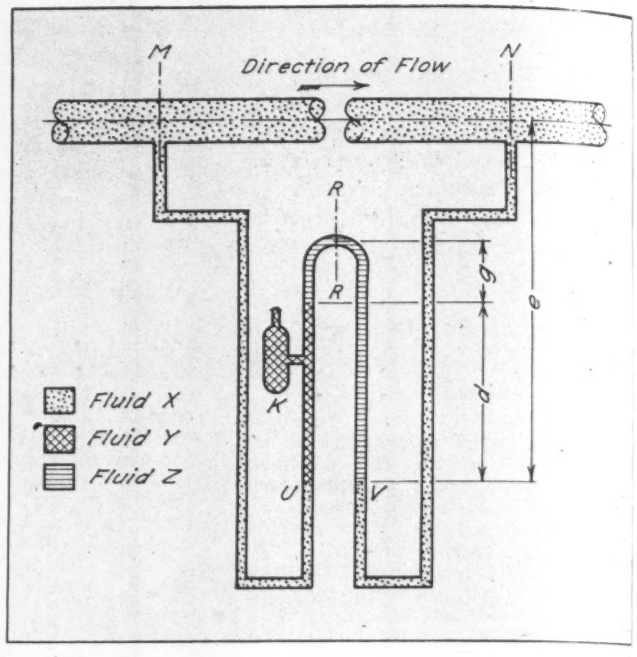


Fig. 4—There are some instances where small pressure differentials must be measured, and considering the particular fluid flowing it may be advantageous to be able to select two other fluids to be used in the manometer to secure the desired magnifying qualities, as is shown here

$$= H_n + e - (d + g)\left(\frac{S_s}{S_x}\right)$$

in which H_m = static pressure at M, ft of fluid flowing; e = distance indicated in Fig. 4, ft; d = manometer reading in Fig. 4, ft; S_y = specific gravity of manometer fluid Y; S_x =specific gravity of fluid flowing from M to N; g = distance indicated in Fig. 4, ft; S_s = specific gravity of manometer fluid Z; H_n = static pressure at N, ft of fluid flowing.

This equation simplifies to

$$H_m - H_n = d\left(\frac{S_y - S_s}{S_x}\right)$$

From the above equation it is evident that if the value of $H_m - H_n$ is expected to be quite small, a large manometer reading d can be obtained if the two manometer fluids Y and Z are so selected that their specific gravities are almost equal, and lighter than X.

As an example, if we assume that the range of an undetermined pressure differential is approximately 0.002 ft of water (specific gravity = 1.0) we might pick the manometer fluids so that $S_y = 0.90$ and $S_z = 0.89$. (This also fullfils the premise that the two manometer fluids shall be lighter in weight than the fluid flowing.)

Then from the preceding equation,

$$d = \frac{H_m - H_n}{\left(\frac{S_y - S_s}{S_x}\right)} = \frac{0.002}{\left(\frac{0.90 - 0.89}{1.0}\right)}$$

$$= 0.2 \text{ ft or } 2.4 \text{ in.}$$

Such a measurement is a sizable one which can be accurately read, even though the pressure difference actually existing is only 0.002 ft of water or approximately 0.00087 psi.

In the use of a manometer of this type it is sometimes necessary to record accurately the temperature of the fluids since the effect of temperature on specific gravity may become important.

VERY HIGH VACUUM BECOMES REGULAR INDUSTRIAL PRACTICE

Nature, which reportedly abhors a vacuum, seems destined to become increasingly exasperated, for war production devices are making amazingly high vacuum a regular industrial practice, according to the Industrial Bulletin of Arthur D. Little, Inc., from which the following information has been taken. As a result, a whole group of processes once technically impossible may become economically feasible.

The limit of vacuum within a container is no gas pressure at all. Air normally exerts a pressure at sea level equal to the weight of a column of mercury 29.9 in., or 760 mm, high; industrial high vacuum practice of the past has rarely reached pressures below 5 mm. By way of comparison, pressures as low as one hundred millionth of a millimeter can now be attained.

The device responsible for these astonishingly low pressures is the diffusion-condensation pump, developed by Gaede in Germany and Langmuir in this country. These small pumps promptly became an indispensable tool of physics, chemistry, and radio tube manufacture. They shoot a high velocity jet of mercury vapor through an orifice, capturing and sweeping along the molecules of the gas to be evacuated, much as an incautious pedestrian is engulfed in a subway rush. This principle, elaborated by other developments such as the use of nontoxic oils instead of mercury, is retained in the new industrial scale diffusion pumps. These pumps are remarkable not only for high evacuation but for the large volumes of gas handled at these low pressures.

Mechanical pumps, however, are by no means outmoded. While they cannot reach the fantastically low operating pressures obtainable with diffusion pumps, recent models reach pressures as low as one hundred thousandth of a millimeter.

Chart Simplifies Solving Problems of Sensible Heat Transfer to Air

Harry S. Byther Presents Data Which Allow for Altitude and Temperature

I HAVE found the chart on the ext page useful for quick solutions f problems involving the transfer f sensible heat to or from an air ream. Its accuracy is within the mits usually imposed by the as-umed data. For absolute accuracy he formula should be used, and rrections made for the water va-or present, but this refinement is arely warranted.

The correction factors for tem-erature and altitude listed on the hart are based on the density of he air in relation to that of air at 0 F and 29.92 in. barometer, the pecific heat of which is taken as 24 Btu per lb.

The following examples illustrate he method of reading the chart. Should the data of the problem go beyond the scales shown, it should be noted that all relations are in direct ratio. For instance, if the air flow is 60,000 cfm, simply determine the answer for 30,000 cfm, and multiply by 2 for the Btu relation, or divide by 2 for the temperature change.

Copyright 1944 by Harry S. Byther.

t will be noted on the chart that the orrection factors for altitude are ore important than those for tem-erature for elevations above 2000 ft

The chart given here by Harry S. Byther, mechanical engineer, may be used to simplify the solution of problems involving the transfer of sensible heat to or from air streams, and has been found useful in ventilation, heating, and air conditioning work. Correction factors for the effect of various altitudes above sea level, and for air temperatures other than the 70 F on which the chart is based, are shown as well. The formula from which the chart was figured is given in its lower right-hand corner.

For our first example, assume a total heat load of 140,000 Btu per hr to be removed from a building by ventilation air, a maximum temperature of 90 F for the air supply, and a maximum temperature of 110 F for the exhaust air. The location is approximately at sea level. An exhaust fan is to be used, and the removal of heat is the reason for ventilating the room.

Entering the chart at 140,000 Btu per hr on the left-hand scale, and going horizontally to the 20 F ($110 - 90 = 20$) temperature difference curve, then vertically to the bottom scale, it is found that the cfm is 6600. Since the location is sea level, no altitude correction is necessary, but the fan will handle 110 F air, the correction factor for which is 1.075, according to the chart. The fan capacity should therefore be $6600 \times 1.075 = 7095$ cfm.

Conversely, the temperature rise may be determined for this sort of problem. Assume that a fan is available which will handle 5000 cfm, and that 150,000 Btu per hr must be removed. Assuming the exhaust air temperature as 100 F, the equivalent capacity of 70 F air is $5000 \div 1.057$, or 4730 cfm. (Note that the correction for altitude is more important than temperature for elevations above 2000 ft). From the chart it is seen that a temperature rise of approximately 30 F will occur.

If, in our first example the elevation had been 2000 ft, the correction factor for this altitude, 1.080, would also be applied. In this event, the fan would be selected to handle $6600 \times 1.075 \times 1.080$ or 7663 cfm.

It should be remembered that this chart does not picture the relations existing when latent heat is involved, and it should therefore not be used if any moisture is added to or extracted from the air stream. In cooling problems, if the temperature of the cooling medium is above the dew point temperature of the air being cooled, the chart may then be safely used, since no extraction of water will occur. If a part of the heat load is latent heat, as encountered in auditoriums, kitchens, or any situation where moisture is added, the chart should not be used for the solution, but a psychrometric chart or tables should be consulted.

Conversion Factors

1 kw	3413 Btu per hr
1 boiler hp ..	33,475 Btu per hr
1 EDR	240 Btu per hr

Useful for quick solutions, accuracy of the above chart is within the limits usually imposed by the assumed data. It does not picture the relations existing when latent heat is involved, should not be used if there is a moisture change

"OPEN for DISCUSSION"

The Drying of Foods

THE EDITOR—

W. B. Van Arsdel's comments in the March HPAC on the author's article on food drying which appeared in the November 1943 HPAC reveal the necessity of a lengthy reply in order to clarify certain questions which Mr. Van Arsdel has raised concerning the article in question.

First, it must be stressed that the article under discussion was not intended nor was specifically stated to be a new or rational method of dryer design. As noted in the foreword of the article, its purpose was to show the relationships of heat and material balances in a compartment type dryer and to demonstrate one method of applying them.

The author agrees with Mr. Van Arsdel that rational design methods are necessary, and he further contends that such methods should be based on fundamental theory and should be verified by fundamental research. In this sense, neither the author's method nor the method of Brown and Kilpatrick, referred to by Mr. Van Arsdel, can be accepted as rational methods, since in neither instance was an attempt made to treat the data fundamentally, but rather empirically.

To clear up some additional misconceptions it should be pointed out first that the author did not necessarily advocate operation of the compartment type dryer at constant wet bulb temperature. Fig. 5 of the article indicates how the wet bulb temperature changes with time during drying. Mr. Van Arsdel's comments on the heater size simply serve to stress an undesirable feature of the compartment type dryer. Obviously, the heater must be adequate for the initially high drying rate in a batch dryer while at the end of the cycle the rate will be so low that the heating surface will be out of proportion. Nevertheless, the heater must be able to meet the maximum demands made on it or the required cycle will not be maintained. Whether or not the dryer is to be operated at constant entering dry bulb temperature will depend on the particular problem at hand and a general statement concerning this feature may be misleading. If proper control instruments are feasible in a given problem, then a temperature cycle can be maintained in the dryer. In the case of food drying, temperature control is imperative and a compartment type dryer should be properly instrumented. Actually, of course, there is a continually changing dry bulb temperature over the trays because the air loses heat for drying. In the limit, a constant temperature could be maintained only by means of an infinite air rate or an infinitely small tray width.

Mr. Van Arsdel objects to the use of a single drying curve for design calculations. In many cases the author has been faced with design calculations where *no* drying curve at all is available. Mr. Van Arsdel doubtless appreciates the fact that many times an engineer is faced with a design problem for which a negligible amount of data is available. In such cases, reliance must be made on the fundamental theories that have been developed and on data for analogous materials to estimate drying rates.

Concerning the paper of Brown and Kilpatrick referred to in Mr. Van Arsdel's discussion, the author would like to offer a few comments. It does not seem appropriate to refer to the method of that paper in discussing batch dryer design, since the latter concerns unsteady-state operation. However, in view of Mr. Van Arsdel's remarks concerning the desirability of rational design methods and general correlations, it seems pertinent to place a few comments on record. First, the treatment of the data by Brown and Kilpatrick is highly empirical, so that general use of the results is not possible without a recorrelation of the data. (This is not to be construed as criticism, for drying studies are generally treated empirically.) Their data as presented are valid only for equipment of an identical nature. In any drying research, it is almost imperative that surface temperatures and areas of evaporation of the material being dried be measured or calculated, otherwise a strictly fundamental correlation is impossible. The true driving force in a drying process is the temperature difference between the air and the solid, and not the wet bulb depression, which is simply an indication of the relative saturation of the air and only shows indirectly the potential causing drying during the overall drying period. It has been found in some instances that the same wet bulb depressions at significantly different temperature levels do not show an identical effect on the drying during the period when the drying rate is continuously falling off. Furthermore, when drying to low moisture contents, it is becoming more apparent that some other driving force is involved, such as (for example) the difference between the moisture content at any time and the equilibrium moisture content.

It should be further pointed out that because of the large tray used by Brown and Kilpatrick in their experiments, the drying curves do not actually correspond to constant temperature conditions for any one run. From the data presented it is estimated that the air over the tray suffered a drop in temperature during the early stage of drying for some runs, of as much as 24 F. This is a large percentage of the dry bulb temperature of the air entering. Hence, it should be concluded that the drying curves rep-

resent some average result for some average dry bulb temperature, and thus the curves are actually typical of a compartment type dryer.

The "factor of safety" referred to by Mr. Van Arsdel is simply a quick method, based on experience, of obtaining the commercial drying time curve which he prefers to obtain by the "less cumbersome" scheme of a graphical method involving a number of curves. To reiterate, very often a designer desires to obtain a quick estimate of equipment size when only a minimum of experimental data is available. To be able to do this seems to the author to be an advantage. Naturally, the proper conversion of experimental data to large scale data depends on a multitude of factors as well as the extent of the development of the theory involved.

Mr. Van Arsdel states that output per unit time is not really basic to the design problem. The author would be very much interested to learn of any design method in which the required capacity is of secondary importance. So far, the author has never yet been asked to perform design calculations without information on the amount of material to be dried per unit time. It seems rather obvious that of all the variables involved in dryer design, the most independent and basic one is the capacity requirement. No matter what approach is made to the design problem, the capacity required will be found to govern either directly or indirectly. Obviously, in compartment dryer operation there will be a certain batch output per dryer per certain number of hours, but this, too, is output per unit time.

Mr. Van Arsdel states that the choice of an average temperature drop across the trays has an "illusory appearance of freedom." This variable is recognized to be important and the statement "illusory appearance of freedom" is not clear. Mr. Van Arsdel states that the temperature drop is dependent on other variables. That is obviously true, but it would be foolish to select air rates and material quantities without considering temperature drop as equally important. The author wonders if Mr. Van Arsdel does not think that the example given by Brown and Kilpatrick likewise gives the temperature drop through the tunnel an "illusory appearance of freedom"?

In their case, the mere selection of the final air temperature virtually determines the size of the dryer, and for this reason it appears that operation is being confused with design, i.e., as though the analysis were made of a dryer already in operation. Of all the variables in drying, the exit air temperature is the one most complicated in its relation to all the others, and its proper determination is a problem in optimum costs, which was not the object of the article in question. It would seem that equation (6) of the author's paper shows to a certain extent how temperature drop is affected by other variables.

In connection with the example of Brown and Kilpatrick, it is important to realize the implications involved in their basic assumption. This assumption states that "the drop in air temperature through the entire dehydrator is related linearly to the difference in moisture content between the entering material and the product." Although this is very nearly true for high moisture content materials, it is unfortunate that this statement was not properly qualified and its extremely specific application to materials with high moisture contents noted. First, it is only an approximation since there are always heat losses and sensible heat effects in any dryer. Second, if it were true, then *the material would remain at a constant temperature throughout the dryer*. If the latter were true then the tunnel could be designed accurately and fundamentally without recourse to experimental data of any kind, except information on tray loading and evaporation areas. However, Mr. Van Arsdel has stated in a private communication that most foods approach the air temperature during the end of the drying operation.

Mr. Van Arsdel deplores the introduction of the constant rate period because of its nonexistence. After learning the size of the trays used to determine the drying curves, the author feels that it would be very difficult to ascertain from tests on trays of this size whether such a period actually exists. This follows because the material at the leading edge of the tray could enter a falling rate period before the material at the trailing edge, and although the former material might experience a constant rate period, it would never be detected. Here again the value of narrow trays for obtaining fundamental data under constant conditions becomes apparent. Other implications in the term "constant rate" should be realized. First, it means that the material is drying with a constant surface temperature. This in itself, as noted above, is important to fundamental theory, and if such a period exists it behooves the experimenter to determine its existence and its magnitude. By private communication, Mr. Van Arsdel has stated that constant surface temperatures on potatoes have been measured to a point in drying corresponding to 150 per cent moisture. The author will submit shortly a paper to show the utility of the period of surface evaporation in dryer design calculations. The procedure will be offered as a rational method.

With regard to the arithmetical error, it would simplify matters to restate the capacity required as 50 lb of bone dry/hr and then no figures need be changed. Actually, it is more convenient to base calculations on the weight of bone dry material because this is a constant quantity throughout the process.

Mr. Van Arsdel's comments on the wet and dry bases for express-

HPAC's readers and editors will welcome your comment on articles or parts of articles published in these pages, and on other topics of interest to those concerned with design, installation, operation, and maintenance of heating, piping, and air conditioning systems in industrial plants, commercial, institutional, and public buildings . . . Address The Editor, Heating, Piping & Air Conditioning, 6 North Michigan Avenue, Chicago 2, Illinois.

ing moisture contents are of value.

With regard to the position of the heater in the dryer, it is worth noting that the value of the heater for equalizing air velocity has no significance in this type of dryer since the air must turn 180 deg before crossing the trays, and certainly any equalizing effect before turning would be totally lost. As far as temperature stratification is concerned, proper methods of installing the heaters can often eliminate this problem. The author has found that in a compartment type dryer, uneven air distribution from the top to the bottom of the dryer can be a most serious problem, and drying cycles have been appreciably shortened by minimizing this maldistribution.

In conclusion, it should be stated that the author's article referred to in these discussions was not intended to be a complete treatmen' of compartment dryers. Space did not permit such completeness Therefore, it is believed that discussions of the nature herein presented are of value in pointing out additional problems and the ramifications of compartment drying, and the author, therefore, expresses his thanks to Mr. Van Arsdel for his interest and contribution to this subject.—DR. W. R. MARSHALL, JR., technical division, engineering department, E. I. du Pont de Nemours & Co.

Now Is the Time to Adopt Metric System

THE EDITOR—

In the February HPAC, Samuel R. Lewis wrote (p. 88), "Of course, it is too much to hope that I shall live to see us adopt the metric system, but its coming is predicted." If the metric system is to come to the United States, it should come before the first half of the 20th century is over. At war's end every manufacturer will offer new items and recatalog many standard old ones. Are we going to rate heating and air conditioning units with "the moribund square foot" and print tons of trade literature and data sheets that way, perhaps later to be cast aside?

Changing yards to meters is a sizable job. Many capable engineers will be coming out of the armed services. Here is a works project that would put many of them to work.—N. S. MACFARLAN.

New Test Method Shows Efficiency of Kitchen Range Grease Filters

THE EDITOR—

I have read the article on grease filters by Messrs. Kliefoth and Hunzicker, published in the December HPAC, with a great deal of interest, and believe the suggested test procedure has many desirable features. We have used in our laboratories for some time a test procedure substantially similar to it.

There are some points which we believe could be discussed with profit. For instance, when the filter is very close to the frying pan it would appear that more of the grease reaches the filter in the form of large particles of ebullition. Under this condition it appears that the filter would indicate higher efficiencies than if it were moved from the frying pan.

We would also like to know if the authors have developed any data on the influence of the grease temperature on the indicated efficiency, and also what effect the air temperature has. Did the authors find the results of the tests capable of consistent duplication? Have the authors developed any data on what might be considered a typical or average air temperature? Have the authors determined whether the water added to the grease affects the efficiencies which are arrived at?

It would seem that it will be necessary to accumulate enough field measurements so that any test procedure would simulate as far as possible the conditions to be met in actual practice.—ARTHUR NUTTING, chief engineer, American Air Filter Co., Inc.

THE EDITOR—

The suggested test procedure for rating range or grease filters published in the December HPAC is, to my mind, excellent and timely. I believe that I assisted at the first application of range filters in 1921. These were installed in the Fountain room of the Hotel Pennsylvania in New York City and continued in successful operation up to the present time (or at any event until very recently).

Range fires have had a bad habit of occurring during the rush hours and the disruption of service can not be measured altogether in actual dollars and cents fire loss. The impatience and irritation of the guest whose dinner is indefinitely delayed is an important factor with the hotel management.

As far as financial savings in the elimination of fire losses are concerned, the National Board of Fire Underwriters has considered the advisability of eliminating the requirement of a separate flue, fusible links, and dampers for range flues if grease filters are installed. Although no decision has been reached by the underwriters on this question, it is apparent that they are a worthwhile fire precautionary measure.

The U. S. Navy Department has conducted some preliminary investigations on this subject and has indicated that it would be interested in cooperating with engineering societies who have this matter under consideration. This field has developed very rapidly in the last few years and a number of manufacturers have offered designs of considerable ingenuity and merit.—H. C. MURPHY, vice-president, American Air Filter Co., Inc., and member of HPAC's board of consulting and contributing editors.

THE EDITOR—

We are quite interested in the remarks of Arthur Nutting and H. C. Murphy and have the following comments with reference to these remarks:

1) We have found that the temperature of the grease varies but very little under different applications. Frying of foods really consists of placing materials, which contain moisture, in the grease. This tends to keep the temperature

of the grease within very small limits. We have a thermocouple set over the frying pan and one thermocouple directly in the grease in the frying pan and are observing the temperature and are comparing these with the test temperature.

2) We find that the test method is of such a nature that tests can be duplicated. The fact that tests which are repeated one after another on the same filter vary only to a very slight degree indicates the accuracy of the test. We are also determining at the present time if different operators will get the same test results.

3) With reference to the question of whether we have developed any data on the influence of the grease temperature on the indicated efficiency, and also what effect the air temperature has, we have the following comments to make:

a) The distance between the stove and the filter canopy is more or less fixed in all installations due to the fact that the height of the stove does not vary more than about 4 in. The average stove is approximately 30 in. We have also found that the average height of the canopy over the stove is 40 in. The reason for locating the canopy at that height is due to the fact that it is assumed that the height of the human being does not vary much more than about 6 in. Considering these limits, we find that the average temperature over the stove is in the neighborhood of 90 F. However, in our work, we test over a range from 80 to 120 F.

b) If the filters were situated vertically in back of the stove, which we believe would be the best method of installing grease filters, the distance between the grease filters and the stove would be considerably less. We have in mind the installation of grease filters on the same principle as chemical laboratory hoods are designed.

4) With reference to air temperature, we have found that the efficiency of a grease filter increases with decrease of air temperature. However, our data are not conclusive on this question.

We should like to point out that we have a rather extensive test program underway. We have asked various manufacturers if they would be interested in having their product included in this test program, but so far only one manufacturer has submitted filters for tests. We have, therefore, designed our test program around two different makes of filters and in this test program all the questions which could arise, some of which are mentioned in the remarks by Messrs. Murphy and Nutting, are being studied. After we have concluded this test program, we intend to publish the data. We, of course, would be very pleased if we could publish this information in HPAC.—M. H. KLIEFOTH, Research Products Corp.

Make Engineering Plans Now for Postwar Construction Work

THE EDITOR—

It is very evident that the war will end some day and at its end the problem of readjustment from a war basis to a peace basis must be properly carried out if we want to prevent unemployment and a real social upheaval. The building industry is one of the biggest employment factors in the country and therefore it must be evident to all that the leaders of this industry, by real planning and forethought, can do a great deal to help the country through this change.

Unless a real effort is made to solve the problem, we will have to see a government PWA program put in operation like the one we had a few years ago and I think no one really wants that repeated.

The Associated General Contractors of New England held a meeting in Boston recently to discuss this matter and to plan for the future along this line.

The state of Massachusetts, through its emergency public works commission, has already begun to employ architects and engineers to prepare plans and specifications for essential and necessary additions, changes, and development of the various state institutions. These plans and specifications will be completed and ready for prompt action when the time comes to provide more employment for the various plants and trades that supply labor and materials for construction. In addition to the above, I understand that there is also being developed by the Massachusetts department of public works another extensive program covering roads, bridges, air fields, and similar projects for use after the war.

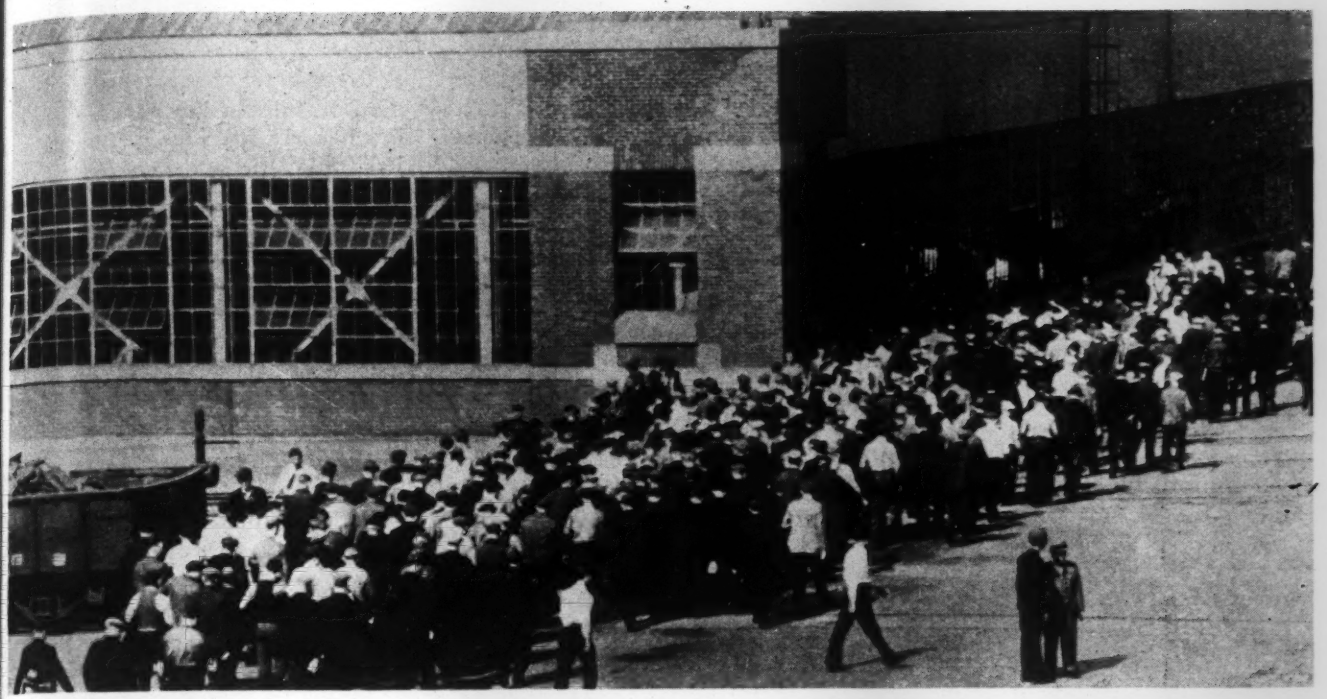
Private owners are also beginning to think of this same problem, and I believe that with proper encouragement many who have not yet started can be influenced to authorize preparation of plans for additions, changes and even new projects for postwar work.

In a recent two week period, this office was authorized to proceed with plans for two hospital extensions, two factory additions, one air conditioning system, a boys' club, and two smaller changes to be done after the war. This is encouraging because it is certain that unless the state and municipal authorities, owners, and managers of property do their part to cooperate along this line they will later find that they will be called upon to pay an equal or greater amount of money in taxes for government financed projects that will not help them as much as work planned by and for themselves.

I do not believe many of us want government operation to supplant, and thus kill, private industry, and I am also sure that another step in that direction will be taken unless we all do our best to help in the readjustment that is bound to occur at the end of the war.

In many cases, unfortunately, there is a tendency to say, "We don't know whether private industry will be allowed to develop freely after the war as the government may continue its rationing of materials, labor, and industry." If this question could be answered properly a great deal more work could be developed for the soldiers returning from the battle fronts and from essential industry.—CHARLES W. KIMBALL, Richard D. Kimball Co., Engineers.

Back the attack! Buy war bonds and stamps regularly.



Heating and Air Conditioning for War Production Factories

Panel Discussion for Plant Men

UNDER THE sponsorship of the member organizations of the Chicago Technical Societies Council, in cooperation with the Army, Navy, and War Production Board, a "war production and related problems conference" was held at the Hotel Stevens, Chicago, March 30. The program for the one-day affair was split up into some 32 panels on as many different subjects, panel No. 31 on heating, ventilating, and refrigerated air conditioning being sponsored by the Illinois chapter of the American Society of Heating and Ventilating Engineers.

Samuel R. Lewis, consulting engineer, was the panel chairman and spoke on the advantages in construction and maintenance by use of liquid heat carriers. Irving E. Brooke, consulting engineer, spoke on heating by radiant energy, and William S. Bodinus, Carrier Corp., gave a presentation on high pressure air distribution in refrigerated air conditioning.

Economies in Construction and Maintenance by Use of Liquid Heat Carriers

According to Mr. Lewis, when a radiator or convector is exposed to air, the rate of heat transfer to the air from the surface of the radiator depends fundamentally on the temperature difference between this surface and the air. The surface does not care how it is made hot—whether by steam or air or water or by direct flame. The speed of movement over the hot surface by the air affects, of course, the temperature difference between the surface and the air.

If water is at atmospheric pressure it boils at about 212 deg, but if water is enclosed under pressure above atmospheric it does not boil until the critical temperature-pressure point is reached, he pointed out. Thus "we are successfully heating a block square, six story factory in Chicago and have done so for years, with hot water at about 30 psi pressure, which does not boil until the temperature is over 240 deg. This much temperature of the water, of course, is not needed until the outside temperature is 25 deg or so below zero."

The pumped hot water is heated by means of steam from an adjoining boiler plant in a copper heat transfer element on the top story. The heated water is circulated through flow and return mains run around the sixth story near the ceiling, with risers run clear down to the basement. The temperature of the water is varied in proportion to the outdoor temperature by means of an outdoor thermostat. Very great savings in cost of heating were accomplished due to the extreme range of water temperature thus permitted, so that there is seldom any overheating, said Mr. Lewis, and the corrosion difficulties formerly experienced ended at once.

The hot condensate from the

transfer heater, after heating the building, warms all the water for the lavatories and lunchrooms, and then, still at about 160 deg, is used in several unit heaters and so is cooled to about 100 deg before returning to the boiler plant.

In another case, in Cincinnati, cited by Mr. Lewis, the original steam heating plant had the boiler in the basement, with the offices on the first story. The Ohio River periodically flooded them out, rising far up in the first story.

He decided, since they could obtain gas for fuel, to move the boiler up on the third story, heating the office on the second story and the warehouses on the first story with forced circulation hot water, all below the boiler. He said he didn't have nerve enough at the time to refrigerate the water and so use the same pipes and valves and convectors the year around. Instead, this plant has separate refrigerant evaporators on direct expansion. This heating and cooling plant has been in satisfactory service for many years. No flood water level can do it much harm.

Mr. Lewis mentioned a plant at Batavia, Ill., which has forced circulation hot water heating, the water being pumped through the air-warming convectors in winter In summer the water comes from two deep wells and after being pumped through the convectors so as to pick up the surplus heat, the water is used for various other purposes, such as in lavatories, for sprinkling lawns, and for evaporative cooling as on roofs. The economy of using the same pipes and convectors the year around would not otherwise be possible, he stated.

In two great blackout plants in Wisconsin, there is 5600 tons of centrifugal refrigeration, Mr. Lewis said. The heat from the tremendous electric power input for manufacturing, and that from the people and lights, is sufficient to warm the well-insulated building until the outdoor temperature is far below freezing. This heat in summer is removed by the refrigerated water circulated through the convectors at the 68 supply fan units in the shops and when heat is required for warming the entering air, the same pumps, convectors, and the same water, warmed to whatever temperature is needed, perform a double duty, so that the only investment cost to gain cooling in summer beyond heating in winter is that for the refrigerating equipment and the somewhat larger convectors and pumps.

Another very successful water using, year around air conditioning system is now nearly 10 years old, according to Mr. Lewis. It is a trust and savings bank building in Chicago. The same water goes around in winter and in summer, heated by steam from the Illinois Maintenance Co. in winter and cooled by power from the Commonwealth Edison Co. in summer.

The refrigerant is common city water, caused to boil at a very low temperature by exhausting the air from above it by means of a 100 hp evacuator. This plant "has had an opportunity to laugh at its contemporaries during the war, since it has no trouble about securing a supply of refrigerant."

We have several very large heating systems, Mr. Lewis said, notably in a high school in Toledo, Ohio, and in a foundry in Chicago Heights, where, since no steam was required for process purposes, the water is pumped directly through the boilers. This permits an exceedingly favorable heat transfer rate from fire to water during most of the heating season when relatively low temperature water suffices, with the added advantage that there is no scale and mud trouble and little boiler water treatment is required, such as is necessary with boiler feedwater which carries precipitable salts.

Frequently it is desirable in large industrial plants, he said, to arrange for heat transmitters well below some existing overhead steam and return system. In such cases a small, local heat transfer converter with a water circulating pump and an expansion tank frequently represent the best solution, from the cost and maintenance angles.

Objection may be made that water may freeze when employed for warming the air in ventilating systems in cold climates, he stated, but said his experience has not indicated that a water-using convector freezes any more quickly than does a steam-using convector, as either will freeze if not receiving an adequate supply of heat and adequate circulation or drainage. An antifreeze solution similar to that used in automobile radiators may be added to the water. He said he had used ethylene glycol satisfactorily in several cases. He has discovered that threaded pipe joints which do not leak water have to be tightened further to be entirely leakproof with the antifreeze solution.

Heating by Radiant Energy

Mr. Brooke prefaced his remarks on heating by radiant energy with a brief review of the fundamental laws of radiant energy, how the human body loses its heat, and the area and surface temperature of the body. Following this introduction to the subject, he said that in considering radiant heating systems it is first necessary to change our ordinary way of thinking about heating in general. We think of a heating system as one where the surrounding air is maintained at a comfortable temperature for human occupancy by direct radiation, a central or unit warm air heating system, unit heaters, etc., but that all of these methods approach the job from the standpoint of heating the air.

Panel or radiant heating first considers the heat balance or heat stability of the human body, he said. The best heating system solely from this viewpoint is the one which maintains this body comfort with the least expenditure of heat energy from an outside source.

Panel heating and radiant heating are often spoken of as the same —and as a general classification this may be satisfactory; however when we wish to distinguish between different types of radiant heating systems we should be more specific, he felt.

He stated that the term "panel heating" did not originate from the practice of installing so-called "heating coils" in the walls, floors, or ceilings. The original "panel" heating system made use of "panels" of cast iron, steel, wood, plaster, asbestos, or other materials usually set flush with the plaster ceiling or walls, he said. These "panels" were generally rather small in area—perhaps only 24 in. x 36 in. to 48 in.—where steel plates

or cast iron were used. Some of these "panels" of steel or cast iron had pipes for steam or water or electric wires attached to the back of the plates. Special panels were made of a light asbestos sheet covered with cork and faced with a composition plaster about ¼ in. thick, in which was embedded a continuous grid of specially insulated wire, making a panel about 1½ in. thick. These were made in sizes 12 in. x 36 in. to 24 in. x 72 in. and for use on current up to 250 volts. They gave a surface temperature of from 120 to 130 F and were arranged so that by switch control in series parallel arrangement they would give 25, 50, and 100 per cent of rated capacity and surface temperature reduced to from 80 to 90 F. In some types of electric heating "panels" the heating elements were encased in glass tubes or shells and placed inside of steel tubes, the pipes then filled with special plaster, then the steel tubes cast in the ceilings or floors. In other types of panels larger diameter tubes were welded to the back of steel plate panels and these tubes acted as heat flues from small gas burners—the products of combustion vented through the extended tubes to the roof or outside.

Radiant systems have been installed using warm air ducts in walls, floors, or ceilings; some have used pipes in the plaster with extended fin surface.

A review of English practice shows that many important buildings have made use of radiant heating systems, he said. The most common has been in the use of continuous ceiling coils of ½ in. or ¾ in. diameter of special quality steel pipe electrically welded, spaced 4 in. to 6 in. on centers laid on the "shutters"—English for concrete forms—and concreted in place. The finished special plaster was applied over a very light weight metal reinforcement on the concrete ceilings. The coil connections to mains or branches are either electrically or oxyacetylene welded. In one building in Liverpool over 55,000 oxyacetylene welds have stood in service over 20 yrs. This building has over 1,000 rooms and was the first large building to be "radiant" heated, installed in about 1910 or 1911. The first installation of this general type was in 1909. In one year one London contractor installed over 75 miles of pipe with over 28,000 welds with no leaks.

Douglas Aircraft has made use of steel tubes, oil filled, with electric resistance wire in the tubes, installed in the floor to give a floor slab temperature of 82 to 84 F. In Holland panels are made of asbestos cement in which is embedded a grid of resistance wire. These panels can be covered with paper, tapestries, etc.

Mr. Brooke then reviewed some of the factors which must be considered in the design of a radiant heating system, and reported owner reactions and experiences with specific installations.

In concluding, he said that the radiant heating system "approaches the ideal," in that low temperatures are generally used over large radiating surfaces. Compare a large room lighted by one very large light in the center of the ceiling with the same room having the entire ceiling illuminated by comparatively low intensity, soft, warm light well diffused by ground glass panels. The light output may be the same in each case, but the illumination is quite different.

"I think it is safe to say that in general the radiant heating system is much more efficient than other types," he said. "Fundamentally the heating system that uses the lowest temperature heating medium, other things being equal, will be the most efficient. Claims have been made of extremely high savings. Comparative records in similar buildings show as high as 30 per cent compared to a direct radiation system. Let's settle for 15 per cent—this is still enough to make it worthwhile."

High Pressure Air Distribution in Refrigerated Air Conditioning

Mr. Bodinus opened his remarks by saying that for 10 years preceding the war there was a progressively increasing demand for comfort cooling, reaching a peak in the late 30's. Although many installations had been made in theaters, department stores, shops, restaurants, general offices and other similar applications, few office buildings, hotels, hospitals, apartments and other multi-room structures had installed complete air conditioning. Although comfort cooling was desirable and had proven that efficiency of personnel was higher in these types of buildings, such factors as cost, inconvenience, structural difficulties, large ducts, and other less important factors materially retarded its universal application. There always was a general dislike of large sheet metal ducts, both by architects and owners, who had felt that some time in the future modern design would eliminate them, he stated.

As the demands of the defense program called for 100 per cent participation by the industry in late 1940 and 1941, the comfort cooling aspect was put aside and all efforts have since been applied to industrial air conditioning and product refrigeration. However, the industrial air conditioning requirements for war have brought about new and interesting developments, some of the details of which will be promptly applied to comfort cooling as soon as the situation permits, he predicted.

One of the engineering problems that had to be analyzed in the building of defense plants was the handling of tremendous volumes of air, yet maintaining proper air circulation, humidity, and temperature in the manufacturing spaces, he stated. These large quantities of air had to be supplied by means of the least expensive and the simplest duct distribution systems employing a minimum of outlets, and in order to satisfy this requirement, the design of smaller sized ducts resulted in a considerable increase in velocity pressure. A more complete analysis of duct construction was necessary and further research was conducted on the coefficients of air flow, and friction factors were established for rectangular elbows with turning vanes, angular takeoffs, increasers, and other changes in shape for higher than normal air velocities.

Fortunately, he said, a considerable analysis of the flow of air was made during the extensive application of comfort air conditioning and the data for the static regain method of duct design was available and put to good use. Also, the necessity for the use of non-metallic substitute materials, in combination with metal corner strips, as well as wood corner strips, required further anal-

ysis of air flow. Temperature loss in duct supply systems, surface temperatures, air leakage and other factors all had to be considered in the war plant, so with all of this information, the postwar comfort cooling system might very well employ some of the lessons learned in these unusual installations.

Paralleling the war plant applications, there was an extensive application of industrial air conditioning for munitions, not only in the testing departments which require intricate duct distribution systems, but in the drying of explosives, fuse loading, and many other applications. Special unit air conditioners were constructed employing high pressure air distribution, and in almost all of these the distribution of air over the product was extremely critical, according to Mr. Bodinus. Humidities and temperatures had to be kept within rigid limits because of explosion hazards and here again the positive control of air, delivered through proper conduits, and supplied by outlets of correct design, was the basis for the perfection of this type of unit air conditioner.

Following this were developments of an extremely unusual nature, such as wind tunnels for testing airplanes, many of them miniature plenums or tunnels for testing models, component parts, such as wing sections, ailerons, rudders, design of wing flaps, etc. These miniature tunnels often operate at static pressures less than atmospheric, yet with dynamic or velocity pressures equivalent to several hundred miles per hour, he stated.

Then came the supersonic tunnel for ballistic research, where projectiles are held in fixed position with air velocities of 150,000 to 200,000 fpm passing over them. Heretofore, the design of projectiles was based largely on the results of actual firing on the range, but now the supersonic wind tunnel is a new instrument that will give much information on the effect of the air on the flight of projectiles. With it, projectiles having a minimum resistance and hence a maximum striking velocity can be designed. It will help to determine the laws governing the flight of projectiles moving at velocities greater than that of the speed of sound.

In the first large supersonic wind tunnel in this country, air will be supplied through conduits at high pressures, and then converted to velocity through nozzles to stream over the projectiles being tested, he reported. Five centrifugal multistage compressors will supply the air under pressure to the tunnels and the supports for the projectiles will be mounted on an intricate balance system so constructed as to measure and record all air velocity forces imposed upon it.

The compressors and interconnecting air conduits which supply the various quantities and pressures of air for the tests have been so designed that they will operate in series, in parallel, or in a combination of circuits to produce a wide range of pressures and volumes. The entire air distributing system of conduits is a closed circuit so tightly constructed that very little leakage occurs and air conditioning facilities are provided so the air is dehydrated before it enters the circuit to a moisture content of 0.005 grains per lb of air. Thus projectiles now stand still and air currents are studied to determine their effect upon materials, turbulence, streamlining, heating effect, and many other details of particular significance to high speed air as it occurs on swiftly moving objects.

High pressure air distribution had been employed in industrial jobs long before the war, and even before World War I. Several conduit air conditioning systems have been installed, perhaps the outstanding one being the new Statler hotel in Washington, D. C., completed after World War II had begun, he said. This hotel, too, was immediately put to war use, accommodating many persons engaged in war activities in some way.

He then described the conduit system briefly, and said that it consists of three parts: (1) a central station air conditioning system supplying the primary air (all outside air); (2) conduit supply duct system which distributes air from the central station equipment to each room; and (3) the room unit through which the air from the conduit enters at a high velocity passing through ejector nozzles. There are no return ducts.

One of the first steps in improving the design of any duct system is to increase its total pressure, Mr. Bodinus said. This increase requires the design of outlets for the increased static pressures, the result being the application of outlets of the slotted, streamline, nozzle, or ceiling diffusion types. The real significance of the high pressure system has practically never been fully realized because too much air noise was produced at the face of the outlets. Low pressure systems usually employed maximum grille velocities of 300 to 500 fpm up to 1930; however, the design of outlets in 1931 was successfully applied without noise with velocities of 2000 fpm. Some installations were made with 2500 fpm without objectionable noise, and for the past 12 years in general, systems have been designed for moderately high pressure at the outlets, he stated.

ENGINEER SEES UNPARALLELED BUSINESS ACTIVITY AFTER WAR

George W. Bacon, of Ford, Bacon & Davis, engineers, whose half-century of engineering activities have been worldwide in scope, predicted last month that this country will enjoy a postwar era of unprecedented prosperity. Mr. Bacon, chairman of the board and a founder, was the central figure in a celebration of the company's 50th anniversary.

"Postwar prosperity in the United States, if not the world, will far exceed during its first quarter of a century any business activity for a like period the world has ever witnessed," ventured Mr. Bacon. Normal inventories having become nonexistent during the war, Mr. Bacon said that in the postwar period "tens of billions of dollars of production and distribution are involved." He foresaw "credit facilities such as our people have never known" and vast sums to overcome "present enormous volumes of depreciated facilities and equipment of all kinds in the United States and beyond our borders."

THE WAR ISN'T WON YET!

WPB...OPA PAW...Etc.

Plan Procedures for Fuel Efficiency Campaign

The nationwide campaign to save coal, fuel oil, heating gas, and other fuels received additional impetus last month in Chicago when officials in charge of the national fuel efficiency program met to plan local campaign procedure. The campaign is to be conducted by volunteers from industry in cooperation with the Bureau of Mines.

Thomas C. Cheasley is supervising engineer for the national fuel efficiency section of the Bureau of Mines. Arlen Z. Jennings, senior fuel engineer of the bureau, has been appointed district engineer by Dr. R. R. Sayers, director of the bureau, and assigned to Chicago, where he will cooperate with area coordinators in Illinois, Wisconsin, upper Michigan, and part of Missouri. John G. Mingle, of the bureau, has been assigned to Indianapolis, as district engineer for Ohio, Kentucky, Indiana, and lower Michigan.

AA-3 Heating Orders Prior to January 15 Take Precedence

AA-3 rated orders for heating, plumbing and cooking equipment placed prior to January 15 will take precedence over lower rated orders which have been re-rated AA-3 in accordance with the provisions of order L-79, plumbing, heating, and cooking equipment, as amended on January 15, the WPB announced March 7.

This action was taken, in direction No. 1 to order L-79, to eliminate any danger of delaying National Housing Agency projects because of disrupted schedules of delivery of required items, WPB explained. The NHA whose orders are rated AA-3, had placed a considerable number of orders for heating, plumbing, and cooking equipment prior to January 15, when order L-79 was amended to allow lower rated orders from distributors to be re-rated AA-3. Since priorities regulation No. 12 gives retroactive effect to such uprating, NHA orders were being delayed because suppliers were filling old orders which had been uprated to the AA-3 level with NHA orders, according to WPB.

SFA Announces Anthracite and Eastern Coke Distribution Plan

The prescribed form of the "consumer declaration" which domestic consumers of Pennsylvania anthracite and of "eastern" coke must file with their retail dealers at the time of or before receiving their first deliveries of those fuels in the 1944-45 "coal year" (which started on April 1) were made public March 24 by Solid Fuels Administrator Harold L. Ickes.

The execution of consumer declarations, Administrator Ickes said, is an important part of the government's 1944-45 domestic coal distribution program and is essential to assuring that each consumer of anthracite and "eastern" coke receives his fair share of the limited supplies of those fuels expected to be available.

The form, which is to be reproduced and furnished by retail dealers to consumers, requires consumers to state their estimated annual needs of solid fuels, their inventory on April 1, the number of rooms to be heated, and the type of burning equipment.

Under SFA regulation No. 17, which will control the retail distribution of domestic sizes of Pennsylvania anthracite, wherever used in the country, and the retail distribution of coke sold in 12 eastern states and the District of Columbia, separate consumer declarations must be filed for each building which the consumer expects to heat in whole or in part by the use of either or both of the two fuels.

Major provisions of the program include the following:

1) Domestic consumers of the two fuels may receive in the whole "coal year" 1944-45 up to a total of seven-eighths of their annual requirements of each or both of the two fuels for space heating, domestic hot water heating, and domestic cooking. The amount they have on hand on April 1 is deducted from the tonnage they may receive.

2) Half of their total annual requirements for each or both of the fuels may be delivered between April 1 and October 1. The amount they have on hand on April 1 is deducted from the amount which may be delivered in this period.

3) Any other solid fuels, used in conjunction with or as a substitute for Pennsylvania anthracite and "eastern" coke, may be delivered to consumers of these two fuels in tonnages sufficient to provide them with their full annual requirements of solid fuels. The amount of solid fuels they have on hand on April 1 and their deliveries after that date will be deducted from the total tonnage they may receive.

Extended Surface Heating Equipment Order L-107 Amended

To eliminate unnecessary hardship on manufacturers of unit heaters and convectors, the WPB announced last month an amendment to schedule I to order L-107, extended surface heating equipment. The changes do not relax the simplification restrictions of the order. They are as follows:

1) In larger housed blower units of standard size unit heaters, it is now permissible to substitute a tube-within-a-tube heat transfer element of no greater heating capacity than that replaced. Formerly, only a tube-within-a-tube heat transfer element of the same heating capacity as the element replaced could be substituted. This change was made because it was intended to restrict the use of larger elements and not to limit the manufacturer to one particular size.

2) Manufacture, fabrication, or assembly of convectors by any producer is limited to not more than 20 sizes of heat transfer elements in each of the permissible depths (6, 8 or 12 in.). A convector is a heat transfer element enclosed in a cabinet that serves as a stack to accelerate the circulation of air through the heating element. Previously, the producer was limited to not more than 20 sizes as determined by the rated EDR capacity. This change will permit manufacturers to make units of different measurements provided they do not involve more than 20 sizes in each depth.

3) Recessed or semi-recessed cabinets for convectors for use in hospitals for mentally disturbed patients may now be produced. Formerly, only wall and free standing cabinets were permitted.

Order L-107 itself was also amended to remove those provisions that made it possible to schedule production of extended surface heating equipment under this order. Order M-293 is the general scheduling order and if it becomes necessary to schedule production of this equipment it can be accomplished under that order.

Repair Shops Have AA-3 Rating for Fractional Horsepower Motors

Repair shops may use the AA-3 preference rating assigned them by controlled materials plan regulation 9-A to obtain fractional horsepower motors from dealers, wholesalers or motor agencies, the WPB said last month.

The AA-3 rating of CMP regulation 9-A was assigned on November 25, 1943, to electricians, plumbers, motor rewinders, electrical contractors, carpenters, blacksmith shops and farm machinery, radio, refrigeration, boiler, automotive, upholstery and bicycle repair shops to enable them to obtain more readily parts and materials for their operations, WPB explained.

Any dealer, wholesaler, or motor agency having fractional horsepower motors for sale is required to honor the AA-3 rating from repair shops if the motors in stock are not needed to fill orders bearing better preference ratings. However, the buyer must be willing to meet the seller's regularly established prices and terms of sale or payment.

Since the demand for fractional horsepower motors for combat services is unusually large, it is necessary to restrict their sale to essential purposes. For this reason, only those fractional horsepower motors needed to replace broken down motors may be sold without a rating, and these replaced motors must be taken in exchange to be repaired where practicable and to be resold under similar conditions. Motors for any other purpose may be sold only on orders bearing a preference rating.

An old motor cannot be demanded by a dealer, wholesaler, or motor agency for a new motor as part of the purchase price on an order bearing the AA-3 rating, it was pointed out.

Emphasis was placed on the repair of broken down motors as quickly as possible because of the shortage of new motors for servicing refrigerators, oil burners and stokers, washing machines, water systems, etc., whose operation, WPB said, is important in maintaining civilian economy and morale.

WPB Revokes Specifications of L-126 on Condensing Units

Specifications for refrigeration condensing units for industrial and commercial refrigeration and air conditioning machinery and equipment were revoked last month by the WPB.

The most important feature of the action was the removal of the prohibition on the use of steel in the construction of bases for refrigeration condensing units having motors over 20 hp in size. Revocation of this restriction will save valuable manhours formerly required to erect concrete bases at the time of installation of the unit, WPB explained. The original purpose of this provision was to conserve steel, but now that the type of steel required is generally more available, it is considered more important to conserve manpower.

The action, which revoked Schedule II to order L-126, industrial and commercial refrigeration and air conditioning machinery and equipment, also removed standardization restrictions which limited the number of models that each manufacturer could produce. Since a large percentage of the units now being produced are for military use and since those produced for the Army, Navy, and Maritime Commission were exempted from model standardization, it was felt by WPB that these restrictions were no longer necessary.

New Minimum Preference Rating for Certain Industrial Equipment

A new minimum preference rating of AA-5 or better, designed to curtail distribution, has been established for 22 classes of industrial equipment, the WPB announced last month. The previous requirement had been A-1-c or better.

The classes of industrial equipment affected by the change in rating requirements, now covered by this amendment to limitation order L-123, include air filters, arc welding machines, flexible metallic hose, tubing and fittings, oil filtering and re-refining machines, certain types of industrial ovens, pressure vessels (including air receivers), and other equipment, none of which was previously under this order.

The order also covers some additional sizes and kinds of compressors formerly under limitation order L-100; high pressure blowers formerly under limitation order L-163; heat exchangers formerly under limitation order L-172; pumps formerly under limitation order L-246; and fans and blowers formerly under limitation order L-280. A number of these kinds of equipment are also subject to general scheduling order M-293.

Deliveries of new equipment covered by the amended order cannot be made by manufacturers, distributors, dealers or other persons except to fill orders rated AA-5 or better. Exceptions to the restrictions are allowed for various cases where deliveries are made in accordance with other regulations, or for certain specified transactions.

Revision of L-41 Order Affects Heating Equipment

The WPB announced last month a minor revision of order L-41, the overall order limiting construction, to make it conform with other recently amended WPB orders also concerned with construction.

Only two substantive changes were made:

1) On airport construction, the limit allowed without getting WPB permission for any job begun in the same year is placed at $1000 as against the limit of $200 which formerly held.

2) The exception previously given to the installation of plumbing and heating equipment rated on WPB form 2631 (formerly PD-851) was revoked. Hereafter, WPB permission under order L-41 will be necessary on all plumbing and heating installations where the cost of the construction including the cost of the equipment is in excess of the L-41 cost limits. Applications for this type of construction must be made on WPB form 2896.

Other revisions merely clarify or reflect recent changes in procedures.

Other Government Actions Taken Last Month

RAILROAD AIR CONDITIONING CURTAILED: Because of heavy war demands for the refrigerant "Freon," air conditioning of railroad equipment will be curtailed this summer, Brig. Gen. C. D. Young, acting director of ODT, announced. The railroads will be allocated only enough to cool their sealed cars, in which the windows cannot be opened, which accounts for 4600 of the 8000 mechanically cooled railroad cars, it is said.

COAL RATIONING NOT NEEDED: The WPB announced it had accepted the Solid Fuels Administration's recommendation that coupon rationing of anthracite and bituminous coal will not be needed during coming 12 months.

GENERAL PURPOSE THERMOMETERS FREED: Standardization restrictions on production of general purpose thermometers were removed by the WPB by deleting these thermometers from schedule VII to limitation order L-272.

FUEL OIL RULE CORRECTED: Seven errors inadvertently made in new regulation for fuel oil and gasoline sales other than at retail were corrected by the OPA in amendment 3 to MPR 88.

HEATER REPAIR PRICING MODIFIED: Charges for repairing and maintenance of gas water and unit heaters may be increased in certain cases as result of change in procedure of determining ceiling prices, according to amendments to OPA order MPR 165.

CERTAIN PUMP RESTRICTIONS LIFTED: Certain restrictions on use of metals in contractors' dewatering and supply pumps were removed by WPB. Wheel bushings may contain copper or copper base alloy; and body construction of self-priming centrifugal pumps may be of iron or aluminum, instead of only iron, according to schedule VIII of order L-217.

FUEL OIL RATIONING REVISED: Primary fuel oil suppliers will find their operation under rationing simpler, OPA said, as result of overhauling of provisions in fuel rationing program affecting their operation and revision of monthly reports they must fill out (amendment 1 to RO-11).

COAL STOKER DISTRIBUTION SIMPLIFIED: Simplification of restrictions controlling distribution of class A coal stokers, type required to heat large buildings, was announced by WPB.

HOUSING CONTROL CONSOLIDATED: By consolidating within a single agency full responsibility for practically all non-farm housing projects, WPB has further simplified procedure for processing of housing construction applications, WPB and National Housing Agency announced jointly.

UNDERWRITERS' LABORATORIES MARK 50TH YEAR

THE first report of the Underwriters' Laboratories, sponsored by the National Board of Fire Underwriters, was issued just 50 years ago last month. Since then, 375,000 products have been approved and are listed as tested and inspected items. Many items of heating, piping, and air conditioning equipment have been included in the thousands of products investigated by the laboratories, and the photos illustrate some of the test procedures used.

Test of temperature limit control for gas, oil, or stoker fired heating equipment. This instrument is the type which opens the electric power circuit of the heating appliance on which it is used. It is being checked for reliability of operation and accuracy of calibration in an oil bath the temperature of which can be closely regulated and recorded. The control is required to shut down the heating appliance and thus prevent excessive or dangerous temperatures from being reached

Thermal insulation used in the walls and ceilings of buildings of all kinds should not ignite readily nor aid the spread of fire in partitions or elsewhere. The section of a partition constructed of 2x4 studs and boards is filled with the insulation being tested. Electrical wires run through the partition and are in contact with the insulation. During the test, the wires are overloaded and are caused to arc by being parted. The partition is then opened to determine whether the insulation ignited or allowed the fire to spread

Laboratory where commercial and residential conversion type oil burners are tested for safety in accordance with Underwriters' Laboratories' standards, and also to determine compliance with Commercial Standard CS75-42. Each burner is installed in a boiler of commensurate size in accordance with the manufacturer's directions. There are 13 boilers in the laboratory, ranging in size from 460 to 7800 sq ft of radiation. Burners are operated continuously and intermittently for a period of 240 hr with the heaviest grade of fuel specified by the manufacturer. Each burner is observed for liability of ignition, continuity of operation, and quality of combustion. Each boiler is equipped with automatic timing and recording apparatus, individual draft controls, and individual fuel supply with all standard grades of test oils available. The laboratories began testing oil burners in 1906, and, to date, have tested for more than 1000 manufacturers

Filters for air conditioning and heating systems are tested for inflammability by placing them in a duct and subjecting them to a wind-driven gas flame. Here, an engineer places a filter in the framework of the duct. Piping from which flame issues is visible. A blower at the right end of the duct (out of the picture) drives the gas flames

It Takes Air to Make 'Em as Well as to Fly 'Em

AIR IS quite as important to the manufacture of airplane engines as it is in providing the element for the utilization of the finished product.

The many varied uses of air in engine production are fittingly illustrated at the Dodge Chicago plant, division of Chrysler Corp., where Wright 18 cylinder aircraft engines are manufactured. In this modern plant—as in all other plants—ventilation is of prime importance and the installations are on a gigantic scale.

Let us take a short trip through the plant and see why ventilation and air are so important to an aircraft engine in the manufacturing stages. We will start in the power house; here, without air, the boilers would be useless, for without air under proper control, combustion of fuel would not be possible. Forced draft boilers also eliminate the tall, telltale stacks, so obvious from the air, and used as landmarks for invading airmen. Though the use of air in the power house is relatively simple, it is indeed of prime importance.

Next let us look at the foundries. Here melting pots full of molten metal await the completion of the cores and molds. At the melting stations, air is required not only for the proper combustion of the fuel used for heating the pots but for fume removal. Thousands of cubic feet of air are required for this process, so that the air breathed by the workers will not become toxic. It is a relatively simple process to remove these fumes if sufficient makeup air is available. This makeup air for the melting stations and also the core and mold baking ovens is supplied from central station systems, situated in the basement. This tempered, 100 per cent outside air is distributed to the various processes through concrete tunnels. The exhaust is removed overhead from these processes, as required.

Additional ventilation supply air and exhaust is furnished by overhead roof units of standard 10,000 cfm and 20,000 cfm capacities. These can be individually controlled as required by the production schedule. There are blanked off openings in the roof which allow for flexibility in the plant layout. Should the processing in the plant be changed, requiring additional ventilation, it can be easily accomplished by adding to or relocating the present overhead units. By this method each process within the building can be individually treated without disturbing other systems.

In the forge shops the process air required is relatively small in comparison with the foundries. Here the main function of the air is to provide good conditions for the hundreds of workers throughout the year, 24 hr per day. Gravity roof ventilation, together with movable window sash, provide the necessary ventilation in these buildings. The small industrial exhaust required is handled through the individual units furnished with the equipment.

Parts from the forge and foundry buildings flow in a steady stream to the machining and assembly building. Both steps are performed in the same building in

In the test cells, treated air must be supplied to simulate flight conditions

segregated areas. This segregation is necessary because the assembly of this metal is done under fully controlled air temperatures, while the machining work is done in only a ventilated area.

General Ventilation Systems

Following the normal flow of the production line we are first concerned with the machining department. Here there is very little need for process air, either direct supply or exhaust. When it is required it is taken care of by individual exhaust units serving the equipment. The exhaust air is taken from the excess air supplied to the building by the general ventilation systems, which maintain a positive pressure in the building. These ventilation systems, of which there are 51 supplying approximately 100,000 cfm each, are situated on the roof. Due to the structural design of this building it was necessary also to place the supply air ductwork on the roof. This ductwork was designed similar to other conventional ductwork except that it was necessary to construct it differently. Since it is entirely exposed to the elements, it was quite important that the ducts be made both watertight and airtight—watertight to prevent rain leakage into the ducts and subsequently into the building, and airtight to prevent excessive air leakage to the atmosphere. The ducts are constructed of wood and asbestos-cement board. The inner shell is made of the asbestos-cement sheets sealed with mastic at all joints. The outer shell of wood sheathing, covered with composition roofing, is separated from the inner shell by 2 by 4 studs. This not only provides the rigid construction required for stability but also furnishes a dead air space for insulation. The interiors of the ducts are accessible from the roof by means of airtight access doors situated at several points along the length of each duct.

In the power houses, of which this is one, air is required for steam generation. The stack at the left serves the incinerator building

From the supply ductwork, air is introduced into the factory area by means of dampered tubes which extend from the roof ducts to the bottom of the cross rib bracing. Distribution of the air at the tube outlet is obtained by means of an adjusted cone suspended from the tube. This cone is very flat and larger in diameter than the tube. This allows the introduction of large volumes of air without causing objectionable drafts on the workers at the floor level. These outlets are all approximately 20 ft above the working floor level.

It might be interesting to mention that these cylindrical tubes are made of noncritical material—two layers of lightweight, waterproof building board, formed at the job site into the required shape, with a holding ring of metal at each end.

The supply air after being introduced into the factory is either recirculated to the apparatus by means of controlled openings in the roof directly under the fan room, or at the direction of the operator it can be exhausted to the atmosphere by means of exhaust fan units throughout the factory area. This system is capable of supplying 100 per cent outside air maximum, or 25 per cent outside air and 75 per cent recirculated minimum, with the exhaust capacity capable of handling the full amount of air supplied or any proportion desired by the operator.

In the heat treat area, a segregated portion of the machine shop, a large volume of outside tempered air is supplied to meet the requirements of the various ovens and processes. Provision is also made for the removal of radiant summer heat by means of exhaust units on the roof, and similar to the ones used in the general machining era. Induced draft fans are used to exhaust fumes from the heat treat pits.

Assembly Department Fully Air Conditioned

The assembly department is fully air conditioned.

Air is quite as important in the manufacture of aircraft engines as it is in providing the element for the utilization of the finished product. This is shown by this "inspection trip in print" of the huge Dodge Chicago plant, division of Chrysler Corp., where Wright 18 cylinder engines are manufactured on a site comprising 500 acres and 19 major buildings. Starting with the power house, our guide takes us through the foundries, forge shops, machinery and assembly buildings, the heat treat areas, and the test cells—describing the importance of air and how it is supplied and exhausted in each case at this big engine plant.

Here the process air is also the ventilation air, as it maintains a constant room temperature so that standard allowable tolerances can be met, no matter what weather conditions exist outside. To allow for full flexibility of the production line and the large assembly area, individually controlled central station systems are used and are situated on the roof. There are 81 of these separate systems each of 60 tons refrigeration capacity and handling 21,000 cfm of conditioned air. Each system is fully automatic and adjusts itself to the load in the area it serves. To insure economy in operation the controls allow for introduction of 100 per cent outside air should outside conditions be favorable. During both extreme heating and cooling periods a minimum of 25 per cent outside air is handled at all times, the proper conditioning of the air being taken care of by the heating or cooling coils, or both, as required.

Each system is complete with cooling and heating coils, filters, 60 ton refrigeration compressor, and evaporative condenser. Any individual system can be shut down for repairs or servicing without disturbing the operation of the others. Since the area served by these 81 units is entirely open, the stopping of one unit will not make any noticeable change in the room conditions, and the production line need not be stopped while waiting for repairs to the air conditioning systems.

As it is desirable to maintain a positive pressure in this area, all excess air is relieved from the building by means of motor operated relief dampers on the roof. These dampers position themselves as required by the position of the outside air dampers on the closest supply unit. By this method the air conditioned area is never out of balance.

To obtain full air coverage in this area, side blow diffusion outlets are used, with no blow carrying more than 40 ft from a distribution height of approximately 20 ft. All ductwork from the fan houses is run inside the building. The supply air from each unit enters the building at four points around a column and serves an area approximately 150 ft by 60 ft. Air is returned to the unit by dampered openings directly under the apparatus.

All ductwork is of asbestos-cement board with metal corner joints. The apparatus housings consist of treated layers of corrugated material separating two external surfaces of asbestos board. This material is structurally selfsufficient and also eliminated the necessity of insulation from the cooling coils to the fan intake.

Test Cells Require Controlled Air Conditions

For final test, the completed engine is taken to the test cells, where it receives a thorough shakedown run, duplicating all flight conditions without leaving the ground or the test cell. Flight conditions are provided similar to the ones encountered in a plane. To do this it is necessary to bring the air to the engine and the test cell. Flight conditions surrounding the engines are produced by huge variable capacity fans supplying air at high pressure to simulate conditions at different flying speeds. Exhaust air must remove the fumes produced by the fuel combustion within the confined area of the test cell. The carburetor air must be conditioned and supplied as required at the direction of the operator.

Only after an engine has been proved in every respect is it given the final approval to fly through the same air that helped build it.

[Albert Kahn Associated Architects & Engineers, Inc., were the architects for this project. The general contractor was the Geo. A. Fuller Co. The heating, ventilating, and air conditioning contractors were Mehring & Hanson Co., Phillips Getschow Co., Narowetz Heating & Ventilating Co., and R. B. Hayward Co.]

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Our New Laboratory

On March 15, 1944, the Society's Research Laboratory, which had been located for the past 25 years in the building of the U. S. Bureau of Mines, Pittsburgh, Pa., was moved to Cleveland, Ohio.

The building, shown in the photograph below, is located at the corner of East 107th Street and Euclid Avenue and is a short distance from both the Euclid Avenue Station of the Pennsylvania Railroad and the East Cleveland Station of the New York Central System.

With exterior dimensions of 91 ft by 57 ft, the building has two main floors, a front and a rear mezzanine, and a large basement. The major portion of both the main and third floors measures 51 ft by 33 ft deep and has a ceiling height of over 20 ft. Some 2200 sq ft of basement space have a 10 ft ceiling height. Office space is available on all floors. The building is heated by district steam.

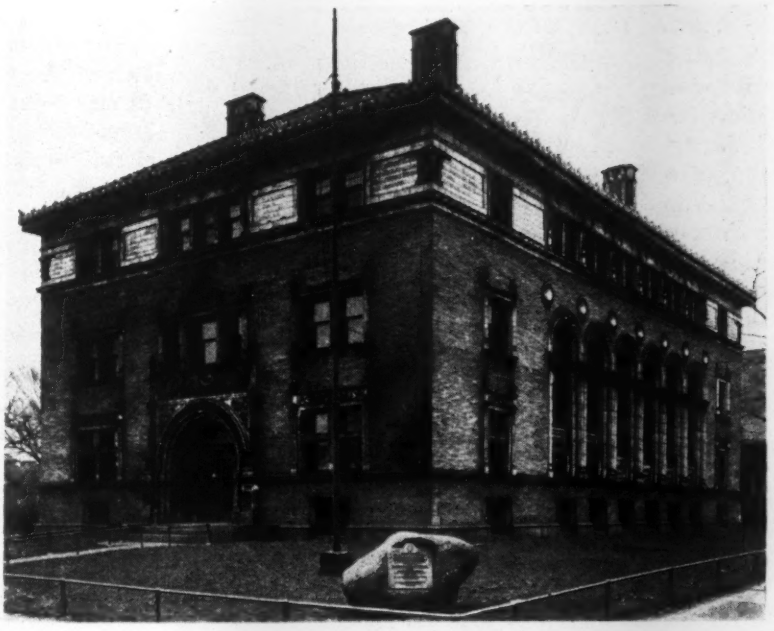
The whole building will be available to the Society for its research work and, as announced at the 50th Annual Meeting of the Society, a two-year lease has been signed with the owners on terms considered favorable to the Society.

The removal to this building offers a challenge to the whole membership of the Society and to the Industry they represent to expand the research work and ensure that, as Research has played an important part in the Great Past of the Society, it will play a still more important part in the Society's Greater Future.

ASHVE

RESEARCH

LABORATORY



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CLEVELAND 6

OHIO

The Aerodynamic Development of Axial Flow Fans

By T. H. Troller,* Akron, Ohio

Development Up to the Present

THE AXIAL flow fan, as it is known at present, consists of one or several rotating wheels, carrying twisted, airfoil shaped blades on a round hub, and of counter-rotating means suppressing the twist in the air set up by the rotating wheel. The elimination of air rotation behind the fan wheel permits building up of high pressure by a fan conveying air essentially straight through a duct.

The basic form of the axial flow fan has been well known for about fifteen years. The aerodynamic design of axial flow fans is an achievement of aerodynamic science. It is founded on the employment of airfoil sections, the characteristics of which have been well established in a great number of wind tunnel tests conducted in the course of aeronautical development during the last 35 years. These characteristics of airfoils, available without specific tests for the use of fan design, were the only experimental data needed. From them rational analysis produced the aerodynamic design of the axial flow fan. The analysis started with the recognition, which in the author's belief was first pointed out in the Russian literature,[1] that in an axial flow fan a continuous flow of *bound circulation* tied to the blades, hub, vanes and the outside wall must exist in such a way as to form a continuous flux corresponding to certain magnetic circuits in electric machinery.

Circulation in aerodynamics is defined as the line integral

$$\int v \cos \theta \, ds$$

along a line enclosing a space in a moving fluid and *bound circulation* is this integral value when taken in the fluid around a solid core to which this circulation appears attached.

In the formula:

v—Velocity at any point of the closed line.

θ—Angle between velocity and this line of element.

ds—Element of the line.

Various publications[2,3] appearing about 1930 connected this thought with the investigation of rotating airfoil wheels in fans until in other publications complete working schedules were developed for the design of the fan structure.[3,4] The very first fans designed according to this scheme proved entirely satisfactory as far as efficiency, stability of the characteristics, simplicity and size of the resulting structure were concerned.

The further improvement and refinement of the theory which appears desirable and to which much thought has been given in recent years has for various reasons not yet resulted in a further technical advancement of the axial flow fan. Also, specific investigation of airfoils and airfoil grids for the purpose of fan design have so far not opened any new ways for improving fans within the range in which they now are widely used.

The one often heard objection to the axial flow fan is that it is noisy. There were and still are axial flow fan installations in existence which are unsatisfactory in this respect. The causes of high noise in these cases may be: overemphasis on fan compactness and therefore unduly high fan speed; very turbulent air inflow to the fan; aerodynamically or mechanically improper fan design; and, in the minority, inherent conditions of the fan operation. As far as such inherent features of the axial flow fan are concerned, however, there is nothing discernible to handicap the average axial flow fan in comparison with older types of air conveyors of comparable size.

Expected Future Performance

A look into the future of fan development suggests investigation of certain absolute limits of performance such as: maximum pressure obtainable in one stage, maximum pressure for a given diameter, maximum pressure for a given speed of rotation, maximum pressure obtainable in a fan of given length, maximum efficiency, minimum noise for a given volume or pressure, etc. An investigation of the limits of the fan in this manner, however, is academic since there is no practical application in which the final choice of the fan design does not constitute a compromise between various aspects such as size, cost of construction, cost of operation and noise level. However, an analysis of a few of these limits as isolated features is of interest.

For an understanding of the action of the axial flow fan it is necessary to consider the basic characteristic of a curved surface or airfoil section when moving through air. Such a typical characteristic of an airfoil, representing the forces on the airfoil as a function of the angle of attack, is shown in Fig. 1. Two aspects in particular are noteworthy:

1. There is an almost linear increase in the *lift force*, which is the force perpendicular to the relative motion between surface and air, in existence over a range of angles of approximately 16 deg. Beyond this range the lift function deviates from the straight line, then a peak in the lift force is reached, and, finally, a reversal or stalling of the lift line occurs.

2. The *drag* of the airfoil or force opposite to the direction of relative

*Director of Research, Daniel Guggenheim Airship Institute. Consultant, La-Del Conveyor & Mfg. Co. Member of ASHVE.

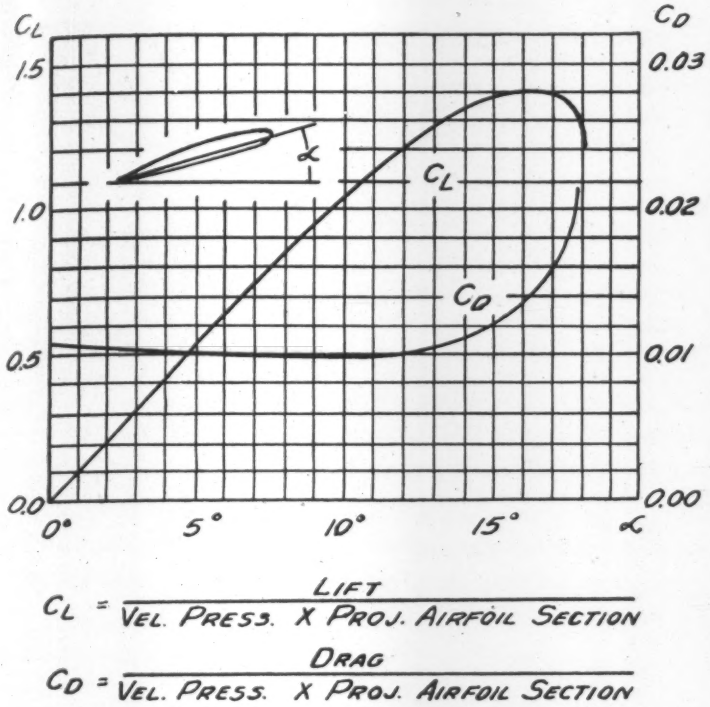
[1]Theory turbillonaire de l'hélice propulsive, by N. E. Joukovsky. (Original in Soc. Math. Moscou, 1912, Reprint Paris 1929.)

Presented at the 50th Annual Meeting of the American Society of Heating and Ventilating Engineers, New York, N. Y., January 1944.

[2]Diagrams for Calculation of Airfoil Lattices, by Albert Betz. (*NACA* Tech. Mem. No. 1022, 1931.)

[3]Axialgebläse vom Standpunkt der Tragflügeltheorie, by Curt Keller. (Gebr. Leeman & Co., Zurich, Switzerland.) Partial Translation—Axial Flow Fans, Keller-Marks, McGraw-Hill Book Co.

[4]Zur Berechnung der Schraubenventilatoren, by T. H. Troller. (On The Design of Axial Flow Fans—1931.) Abhandl. aus dem Aerod. Inst. Aachen, Heft 10—Verlag Springer, Berlin, 1931.



$$C_L = \frac{\text{LIFT}}{\text{VEL. PRESS. X PROJ. AIRFOIL SECTION}}$$

$$C_D = \frac{\text{DRAG}}{\text{VEL. PRESS. X PROJ. AIRFOIL SECTION}}$$

Fig. 1—Characteristics of an airfoil section suitable for fan blade design

notion is small relative to the lift orce obtainable over the major range f the straight relation range between ngle and lift force.

The linear connection between ngularity and lift force re-appears n the fan characteristics as an most linear connection between olume and pressure in the fan over wide range. The peak re-appears n the fan characteristic as a stall- g point or at least as a definite end in the characteristic pressure- olume curve of the fan. The exact ature of the effect of the *stalling* f the airfoil sections forming the an blades depends largely on the ngle setting of the blades against heir plane of rotation and also on ome other factors. The low drag oefficient of the airfoil sections eans essentially that in the angle f attack range of the blade sec- ions, where these favorable condi- ions exist, small losses and there- ore high efficiencies are obtainable n the axial flow fan.

This characteristic of the airfoil aken from wind tunnel tests deter- ines maximum pressure and max- mum efficiency that can be ob- ained in a fan since it is little dif- erent from the characteristic of he blade sections employed in fan lades. The maximum lift coeffi- ient of the fan blades is essen- ially comparable to that measured in wind tunnels and, therefore, the maximum pressure obtainable from a fan blade is limited to the lift force obtainable on an airfoil section. There are tests available which would indicate higher lift peaks on airfoil sections arranged in a fan than on the same airfoil measured by itself in the wind tunnel. These differences, according to present knowledge, would, however, not have a large effect on the behavior of a fan. As an approximate figure we may state that a fan wheel can develop a pressure approximately equal to 1.2 to 1.6 times the dynamic pressure of the rotation-velocity existing at the hub section of the propeller wheel.

The absolute limitation in pressure obtainable in one wheel is given by that blade velocity which forms the limit for efficient action of airfoils with lift forces corresponding to this pressure peak of 1.2 to 1.6 times the velocity pressure on the blade. This limiting velocity, depending somewhat on the shape of the section is equal to approximately 80 per cent of the velocity of sound or about 880 fps. A fan wheel running with such a tip velocity could develop roughly 135 in. water pressure, assuming the hub diameter to be equal to 0.9 times the tip diameter of the blades.

Several means are known for increasing the peak lift developed on an airfoil beyond the value shown in Fig. 1. They consist of additions to or variations from a plain airfoil such as shown in Fig. 2. The highest lift peaks are obtainable with airfoil sections using *boundary layer suction* which would bring about peak lifts up to three times that available with a plain airfoil or curved section. Any employment of such means will of necessity complicate the otherwise strikingly simple appearance of the axial flow fan. The *boundary layer suction* would consist in the removal of a thin layer of air, the so-called boundary layer, from the surface of the blade, by taking it through openings into the inside of the blade and then discarding it again at a suitable location. It should be expected that developments of this nature will appear in the future and that with such developments increased pressures in one wheel will be used for a given turning speed of the fan. Regard-

SLOTTED AIRFOIL

C_L = VALUES UP TO 2.0
C_D = MODERATELY INCREASED

AIRFOIL WITH FLAP

C_L = VALUES UP TO 2.5
C_D = STRONGLY INCREASED

HOLLOW AIRFOIL WITH BOUNDRY LAYER REMOVED BY SUCTION

C_L = VALUES UP TO 5.0
C_D = LOW, BUT SPEC. ENERGY FOR SUCTION IS NECESSARY.

Fig. 2—Variations from plain airfoil sections

ing the velocity limit, at which such a special blade section can be successfully applied, it should be observed that the very high C_L values with simultaneous low C_D values would be possible only for a range considerably lower than 0.8 times the sound velocity.

The efficiency limit as it would appear in the light of the airfoil theory would be represented by the formula for one blade section at a radial station. (For the fan as a whole the efficiency would be given by integration over the whole radius. In the simple form given here an average section is substituted for the whole blade.)

$$\eta = \frac{1 = \epsilon\,\lambda}{1 + \epsilon/\lambda}$$

Where

ϵ = ratio of drag to lift for the average blade section.

λ = ratio of the velocity component of the air relative to the fan blade in direction of the fan axis to the velocity component in peripheral direction of the relative movement.

μ = fan wheel efficiency.

Assuming that energy losses in the fan outside of those due to the friction on the blades are relatively small, this efficiency formula would indicate that a peak of efficiency is reached when λ is approximately equal to 1. This would mean the airfoils stand at nearly 45 deg against the plane of rotation. Introducing for ϵ a value of 0.01 as measured in wind tunnels, possible efficiencies of about 98 per cent for the fan wheel itself are obtained. If to the losses occurring in the wheel are added those losses which have to occur in the countervanes or other counter-rotating means and in the rest of the motion of the air through the fan, it can still be assumed that ideal efficiencies of 95 per cent would be feasible if obtaining such efficiencies were the only consideration in the design of a fan.

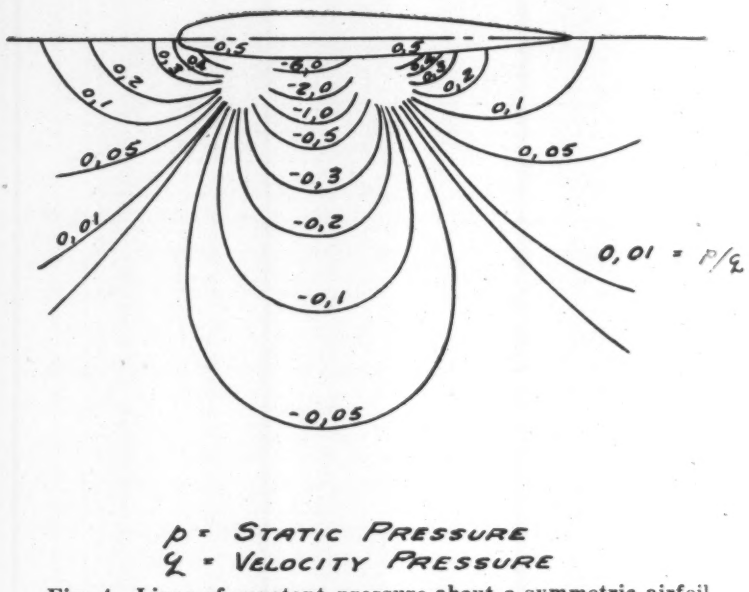


Fig. 4—Lines of constant pressure about a symmetric airfoil at zero angle of attack

As far as driving the efficiency of a fan to the theoretical limitation is concerned, it can be stated that a rapid increase in bulkiness and cost of the fan structure occurs beyond a point which lies between 75 per cent to 85 per cent fan efficiency to such an extent as to force in most cases the limitation of the efficiency to this range or, at any rate, to a value of under 90 per cent.

Before leaving the discussion of fan pressure and efficiency, there is one other feature of the axial flow fan that merits mention regarding future development, namely, the possible increase of flexibility and of operating range of an axial flow fan by means of pitch adjustment of the blades. Pitch adjustment has become common for propellers of most airplanes and we may expect that a corresponding development will bring the advantages of adjustable pitch to many axial flow fan applications.

Fig. 3 shows pressure-volume characteristics, power-volume characteristics, and efficiency-volume characteristics for an axial flow fan with adjustable pitch at a number of pitch settings for a fan of 36 in. diameter delivery at rated capacity of 18,500 cfm against 4.5 in. static pressure. Any one single curve relating the power to the air delivery at a set blade pitch angle becomes the flat power curve generally existing at fixed pitch. This

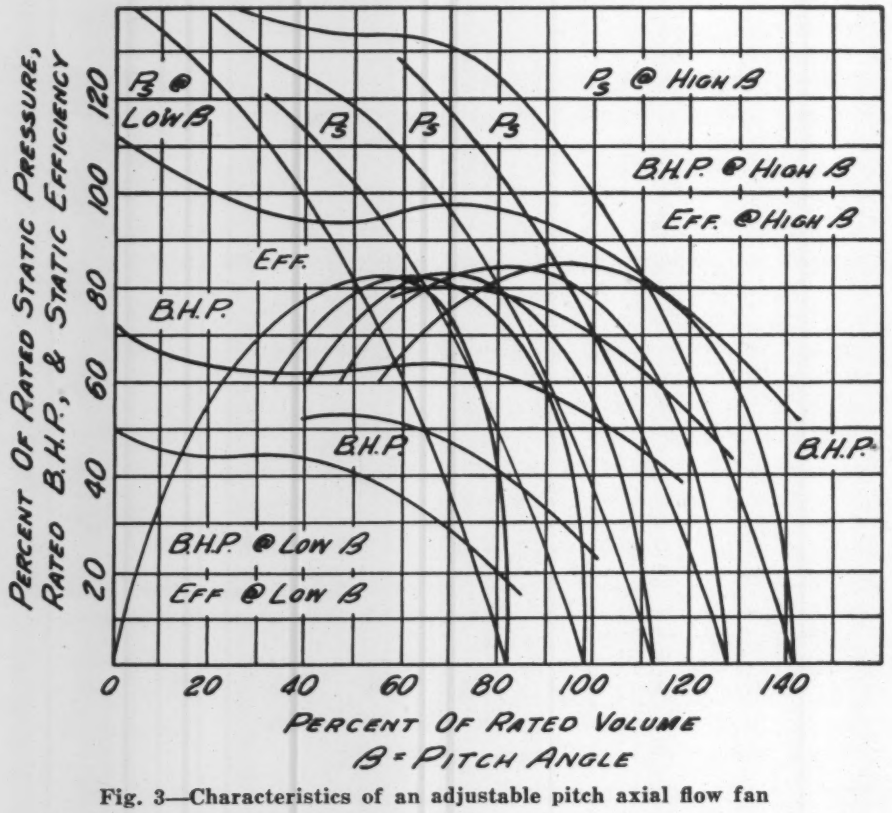


Fig. 3—Characteristics of an adjustable pitch axial flow fan

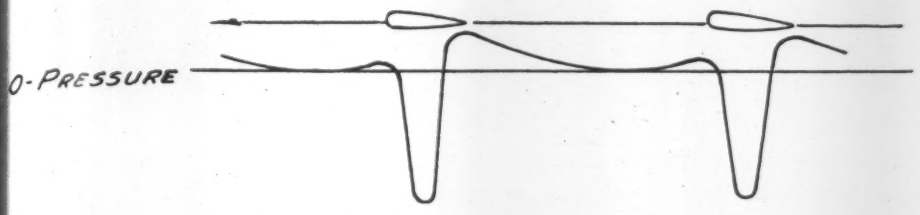


Fig. 5—Pressure field along a line near an airfoil section parallel to its path of rotation

flat power curve of the fixed pitch axial flow fan permits the designer to dimension the driving motor essentially for the power required at the main operating point. However, there is no immediate saving in power consumption at low deliveries of air when such a change from the main operating point of the fan characteristic is required at some period in the life of the fan. To obtain a saving in power or to change air delivery through a given duct system in a desired manner without regulation involving losses, pitch setting of the fan blades is employed most successfully, as indicated by the resulting characteristics of Fig. 3.

It is the author's opinion that an appreciable range of regulation for axial flow fans can be accomplished only by means of pitch setting of the blades and further, that the extension of the operating range by means of setting of the stationary vanes is restricted to such small limits that it appears to be of doubtful advantage. The pitch setting of the rotating blades is, of course, more involved mechanically than that of the stationary vanes but whenever an additional complication of the fan is worthwhile, it should also justify a mechanism for setting the pitch of the blades. This pitch setting of the blades can be accomplished by various designs and it can be applied: by setting the blades once during the fan installation to fit them to ducts; or by setting the pitch with simple mechanical means in rest periods of the fan; or finally by setting the pitch on the running propeller by hand or automatic steering devices. The type of mechanism adjustment to be chosen in each case would depend upon the purpose of the individual fan installation.

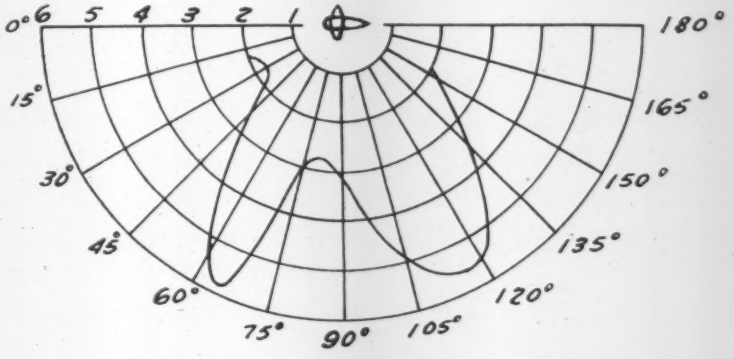


Fig. 7—Sound pressure field about a three bladed propeller (same as in Fig. 6)

Aerodynamics of Fan Noise

In addition to forming the basis of the pressure and efficiency computations, the aerodynamics of the airfoil also explain the necessary appearance of noise in axial flow fans. If contributions to the noise due to imperfections in the fan structure are neglected, the fact remains that a source of sound is inherently connected with the rotating fan blades. Each airfoil is surrounded in its movement through the air by a field consisting of regions of lowered and raised air pressures (see Fig. 4 for the simple case of a symmetric airfoil at zero angle of attack). An airfoil or a series of airfoils arranged in a rotating disc brings about a field of periodically changing pressures in any one point of the space in the immediate surroundings of the propeller disc (see Fig. 5). This periodically changing pressure field constitutes a source of sound waves which will emanate from the space of pressure disturbances. The sound-pressure field due to this peculiar source of sound is of more complicated form than, for instance, that of a simple membrane. At any reference point at a distance where the immediate pressure changes due to the moving blades could no longer be recorded sound waves arrive from the regions of periodically changing static air pressures and densities. These sound waves interact with each other so as to form a noise-level pattern based on the frequency of the emanated sound and on the shape of the pressure field surrounding the fan wheel.

The main frequency of the necessary noise is equal to turning speed times the number of blades. The shape of the pressure field depends on the number of blades and on the radial distribution of the pressure on the blades as well as on the

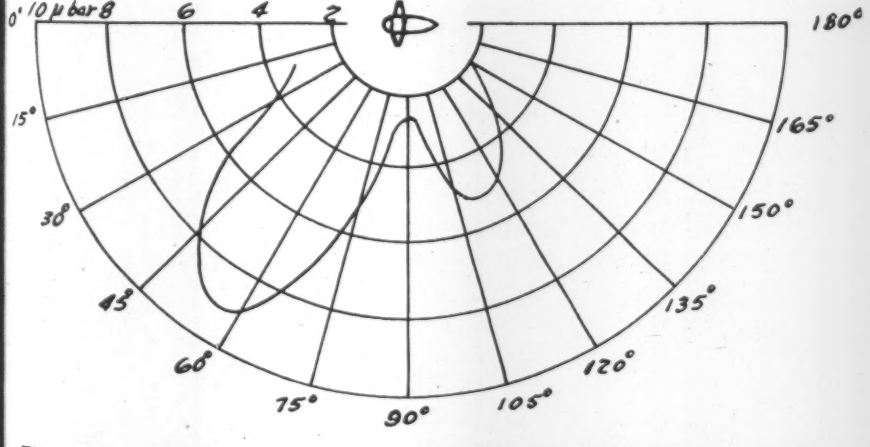


Fig. 6—Sound pressure field about a two bladed propeller (line indicating pressure along a concentric circle about the propeller)

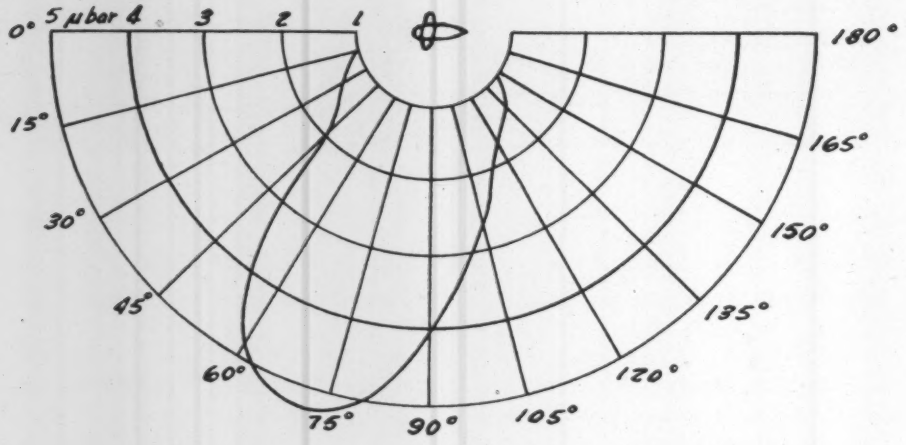


Fig. 8—Sound pressure field about a five bladed propeller (same as in Fig. 6)

peripheral pressure distribution along the path of the rotating blade sections and, further, also on the fan structure surrounding the rotating wheel.

The resultant sound level pattern contains lines which are radial at large distance from the fan and somewhat curved in its close vicinity, along which the measured sound reaches considerably higher values than at points between their angular sections at equal distances away from the fan center. The existence of such sound level distribution patterns is known from theoretical and experimental investigations of airplane propellers[5, 6, 7, 8]. Typical distributions for two-, three-, and five-bladed propellers are shown in Figs. 6, 7, and 8 in which lines of equal sound pressure are given as recorded in airplane propeller tests. In these tests noise peaks, for a two-bladed propeller, occurred under an angle of 55 deg, and then at 110 deg, measured from the forward extended axis of the rotating wheel in a plane through the propeller shaft. For a three-bladed propeller of the same speed and diameter and similar blade design, the peaks were obtained at 65 deg and 115 deg. For a corresponding five-bladed propeller the peak was obtained at 75 deg. The indicated noise levels are those of the main frequency of noise. Contributions of frequencies other than the main source of noise are in existence and would have a pattern of their own. Such other tones are partly related to the turning speed of the fan and are partly independent of the fan speed. In the latter class we have in particular the oscillations occurring in the frictional wake behind each rotating blade as a necessary source of noise. These other components are, however, usually of minor importance.

Compared to that of an airplane propeller the sound level pattern around an axial flow fan exhausting from or blowing into a plenum chamber is further complicated by the fan housing and particularly by a bell shaped intake. Some preliminary checks regarding such noise patterns for fans exhausting from a plenum are shown in Figs. 9 and 10. They bring out essentially the same character of the sound field as obtained theoretically and experimentally for airplane propellers even though these particular tests suffered from somewhat unsatisfactory test conditions in the laboratory. The existence of such a sound pattern should be taken into consideration in the establishing of testing specifications for fans because it may well be possible by choice of the number

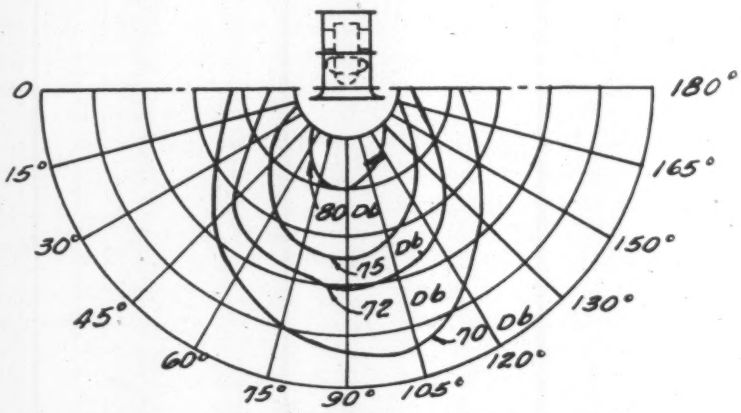


Fig. 9—Sound level field about a two bladed axial flow fan revolving at 3500 rpm (equal noise level lines as function of the location relative to a fan exhausting from a plenum)

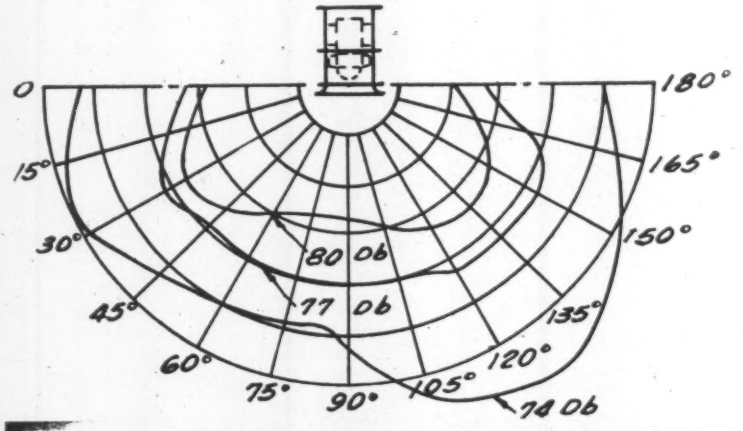


Fig. 10—Sound level field about a four bladed axial flow fan revolving at 3500 rpm (equal noise level lines as in Fig. 9, fan of Fig. 10 is not equal in size and performance to that of Fig. 9)

[5]The Source of Propeller Noise, by W. Ernsthausen. (*NACA* Tech. Mem. No. 825.)

[6]Neuere Untersuchungen über das Luftschraubengeräusch, by W. Willms and W. Ernsthausen. (Luftwissen 1938, pp. 128-134.)

[7]Investigations of the Origin of the Sound Emitted by Revolving Airscrews, by Obata-Yosida. (Rep. of the Aero Res. Inst. Tokyo Un. No. 132.)

[8]On the Direction of Properties of Airscrew Sound, by Obata-Yosida. (Rep. of the Aero Res. Inst. Tokyo Un. No. 134.)

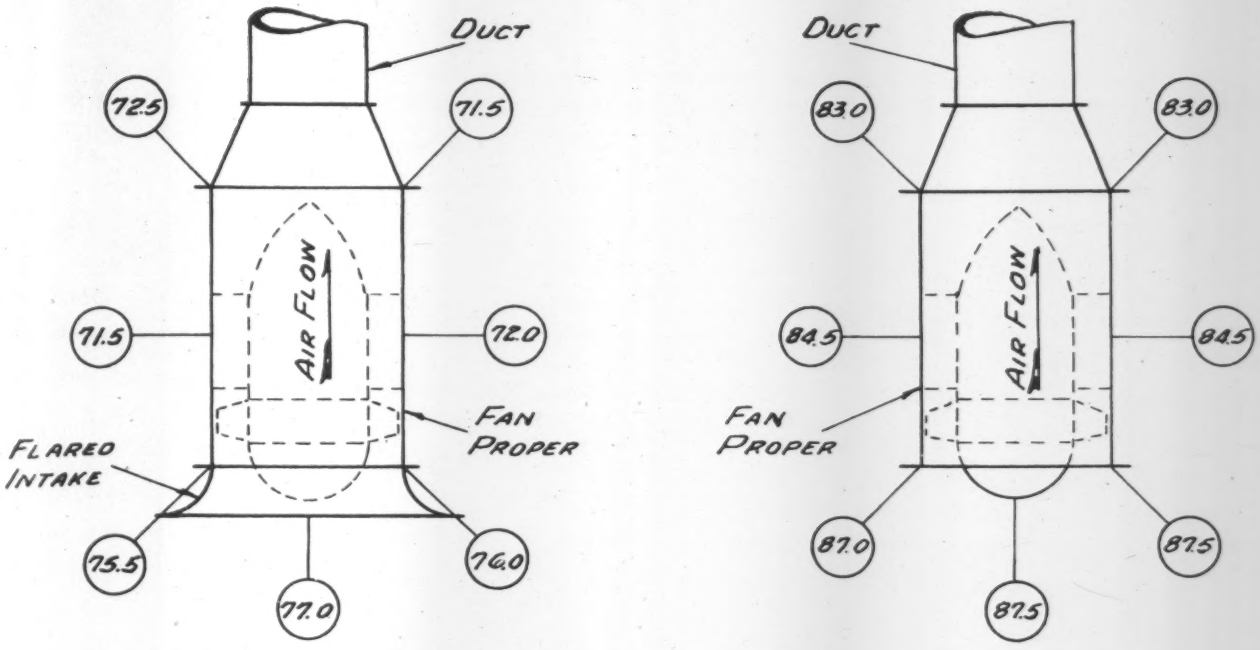


Fig. 11—Comparative noise levels (in decibels) about a fan with flared and sharp edged intakes

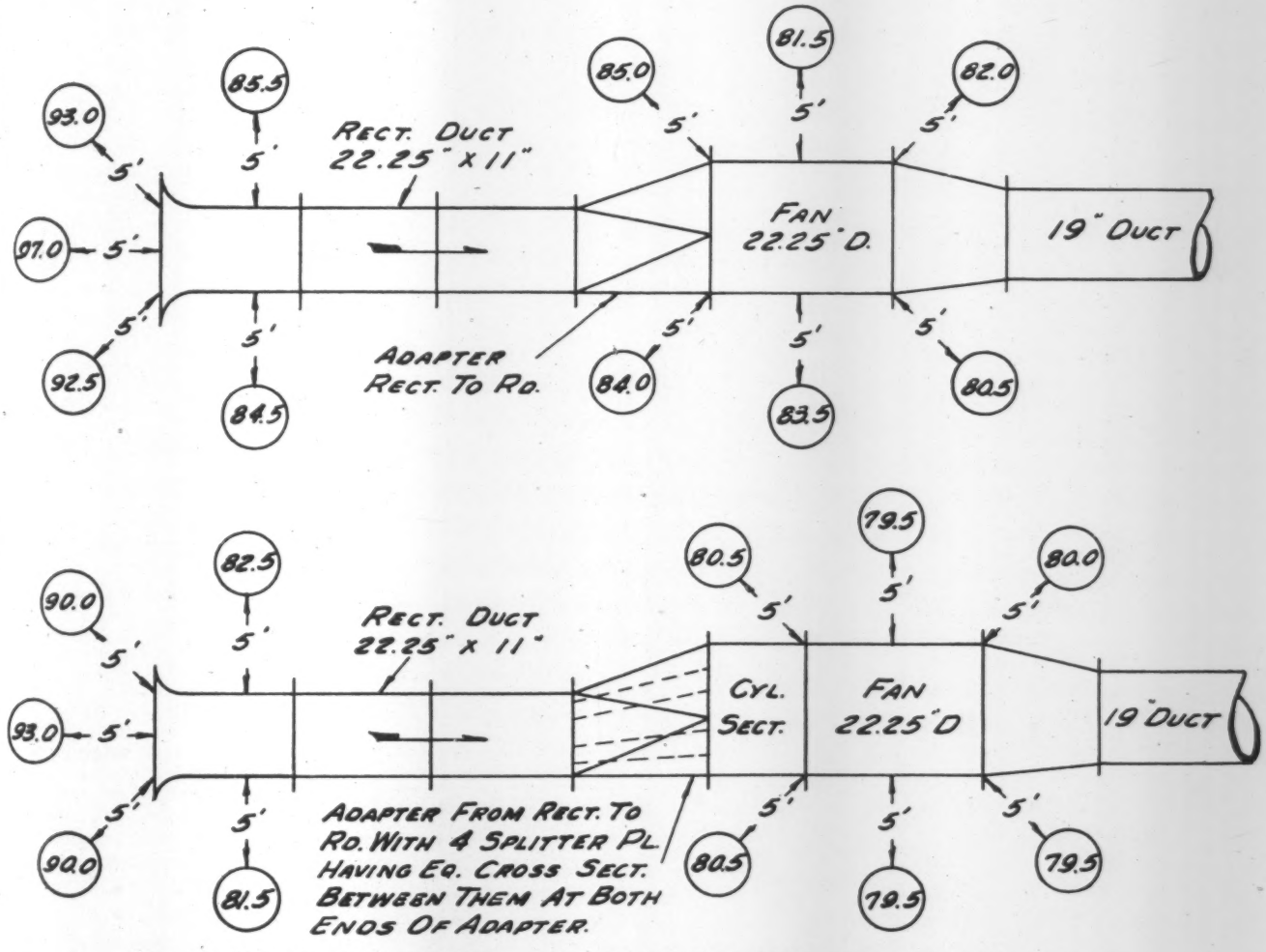


Fig. 12—Noise level (in decibels) on a fan installation behind a sharp change in duct contour

of blades to avoid pressure peaks at arbitrary points specified for such sound measurements without improving the noise characteristic of the fan throughout the space.

The noise level produced by a fan of given geometric outline is closely proportional to the tip speed of the blades, except for those noise components not inherently connected with the fan action.[9] Measured in decibels it is, over a wide range, a linear function of the logarithm of the tip speed, with the proportionality factor depending on distance from the fan, fan size, etc. The absolute lower limit of the noise level of a fan would perhaps be given by that size and velocity of the blades at which a falling-off of fan efficiency would occur. The lowest permissible value of the product blade width x blade velocity for good efficiency is of the order of magnitude of 2000 sq in. per second. Assuming a fan with a blade width of 5 in. at a hub of 15 in. diameter, this value would correspond to a fan turning speed of approximately 500 rpm. At this speed a fan wheel of present common design and, for instance, of 30 in. outside diameter, producing about 0.3 in. of pressure would have a noise level of less than 67 db (measured as an average of seven stations at 5 ft from the fan) if only inherent aerodynamic occurrences in the fan are considered.

Future improvements in the noise level of axial flow fans will consist in the author's opinion: (1) in judicious consideration of fan dimensions; (2) in avoidance as far as possible of all additions to the basically necessary noise level; (3) in a study of possible improvements of the sound pattern connected with the arrangement of revolving blades by proper distribution of the aerodynamic pressure pattern over the disc area; and, (4) in employment of sound deadening or damping means either in the form of noise absorbents or of properly chosen resonators.

It is difficult to guess the further possible reduction of the noise level of axial flow fans. The variables entering into consideration have as yet, in the author's belief, not been subjected to a complete systematic investigation along lines similar to those carried out for aeroplane propellers. Such an investigation should establish mathematical expressions describing the effect of variations in the static pressure pattern around the rotating fan disc similar to those used in the study of propeller noise. To this should also be added an investigation of the effect of the installation to which the fan itself is attached.

Installation of Fans

The foregoing leads to the consideration of fan installation in general. Careful handling of the attachment of the fan to the connecting duct system will eliminate many sources of present complaint about fan noise and also sometimes of unsatisfactory air delivery.

Two examples of the effect of the installation on the resultant noise level are the following:

Fig. 11 shows noise level tests on a fan exhausting from a plenum chamber having a bell-shaped intake, and also on the same fan at identical conditions with a sharp-edged intake opening.

The noise reduction due to the flared intake will also depend on the size and shape of the flares. In one particular case the following variations were found in the noise for flares attached to a fan of 15½ in. diameter, when the flares were changed in size, while retaining the quarter-elliptic shape:

Max. flare dia./fan dia.	2.0	1.75	1.5	1.25
Noise level at position 5 ft ahead of fan....	84.0 db	82.0 db	80.5 db	80.0 db
Average noise level (standard tests).....	78.8 db	78.2 db	77.7 db	77.3 db

This particular series of tests would indicate that a flared intake just large enough to assure reasonably smooth inflow to the fan is most favorable for a low noise level. Other available information, however, makes it questionable whether general use of flares as small as 1.25 times the fan diameter is advisable. Rigid installation rules cannot be given until a more complete analysis of the sound pressure field about a fan is available.

Fig. 12 shows a particularly striking example of an undesirable form of installation of a different nature from that of Fig. 11. It represents a fan installed within a duct closely behind an abrupt change in duct cross section and alignment. This leads to an uneven flow of air into the fan wheel and related with this uneven flow, to a lowered performance and greatly increased noise. A complete remedy of the bad effects of the sudden change in direction and change in

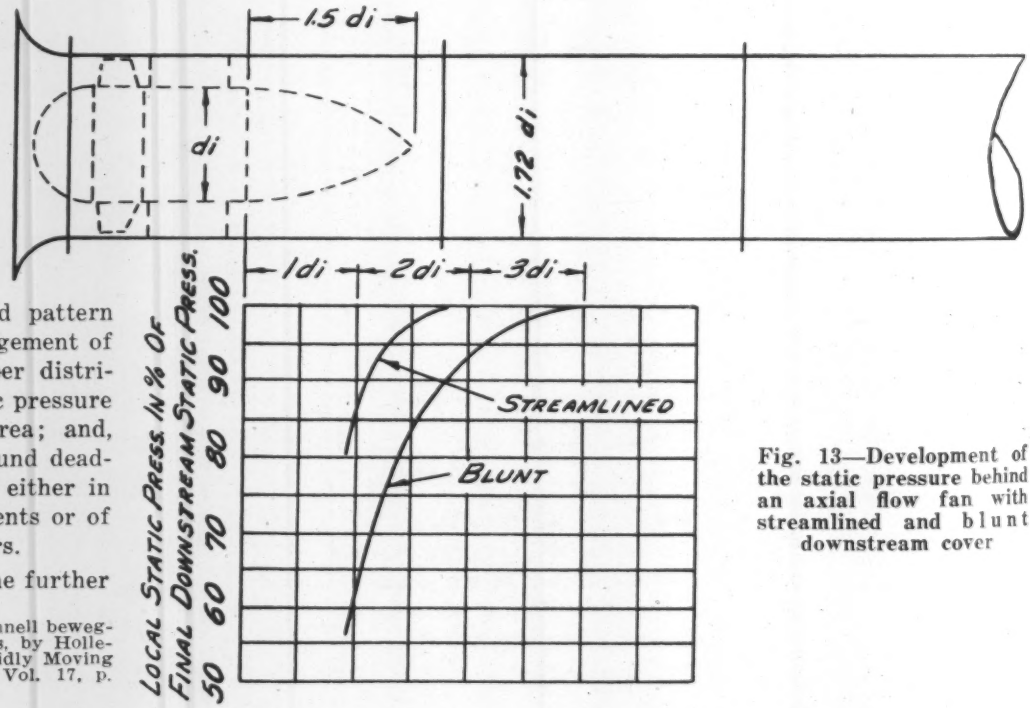


Fig. 13—Development of the static pressure behind an axial flow fan with streamlined and blunt downstream cover

[9]Zur Schallstarke des von schnell bewegten Profilen erzeugten Schalles, by Holle-Lübcke. (Noise Level for Rapidly Moving Sections—Luftfahrtforschung, Vol. 17, p. 56, 1940.)

cross section on the fan performance cannot be given, but a partial relief can be obtained by securing a more even flow of air into the fan by means of the guide plate arrangement shown in the cut.

In installing a fan caution also should be exercised to obtain the pressure for which the axial flow fan is rated. A fan having a streamlined tail as cover over the downstream side of its hub takes care of itself. Fans with blunt cutoffs in their center, however, in addition to having lower efficiency, also require a length of straight duct downstream for the build-up of the static pressure credited to them by standard test procedure. The test results given in Fig. 13 illustrate the conditions for an average case of this type. Also, a tail-less fan blowing into a plenum chamber immediately adjacent to the downstream fan end should not be expected to build up the pressure measured for fans installed in a long straight tube.

Conclusion

The axial flow fan is essentially based on the aerodynamics of airfoils. Its performance may be further improved by a still better understanding of the forces developed on airfoils, by increased knowledge regarding the details of the pressure and of the sound field created by the rotating airfoils, and by the utilization of improved sections in the design of fan blades. Careful study of the fan installation will make certain that the fan operates as well as its test-stand performance would indicate.

Discussion

A. E. Criqui, Buffalo, N. Y. (written): The author has given a good presentation of many of the details in the design of axial flow fans. The use of aerodynamics in aeronautical work usually assumes free flow conditions, that is, a body immersed in an infinite fluid. When these same concepts are applied to fan design, the problem is complicated by the confining boundaries of the fan. The mutual effect of blades must be considered, also the effect of the fan housing and fan hub. Likewise for the guide vanes, it is not enough to consider them as highly cambered airfoils. The full fan performance curve from shutoff to free delivery takes in a much wider range of angle of attack than used in aeronautical work.

The author's opinion is that appreciable volume control can be accomplished only by adjusting the pitch of the blades. There is another means in extensive use on high pressure axial flow fans. This is by using variable inlet guide vanes, controlled by a damper motor. These vanes in one setting act as inlet vanes. They rotate the air in a direction opposite to the wheel rotation and thus increase the normal performance of the fan. When these vanes are rotated to a closed position they not only reduce the air volume, but the fan horsepower as well. With this arrangement, capacities are reduced to considerably less than 50 per cent. Horsepower too is reduced a comparable amount. The fans under discussion are large size, running at high speed. By keeping the control on a non-rotating part in this case a very satisfactory solution is obtained.

The constant in the fan noise laws is fairly well agreed on as the following:

$$\text{db change} = 50 \log_{10} \frac{\text{RPM}_2}{\text{RPM}_1} \text{ or}$$

$$50 \log_{10} \frac{\text{tip speed}_2}{\text{tip speed}_1}$$

It is to be noted that this law assumes constant rating point and constant size. This law has been accepted by the *National Association of Fan Manufacturers* and is given in their Bulletin No. 104—Sound Measurement Test Code for Centrifugal and Axial Flow Fans.

This code qualifies the law by limiting its application to a range of 10 per cent speed change. One reason for this is to allow for noise components, as the author states, not inherently connected with the fan action. An example of such an extrinsic source might be the motor in the case of a two-speed fan. Assuming an abnormally loud motor, and a quiet fan, at the low speed the motor might make a sizeable portion of the entire unit noise. At high speed the motor noise, if it did not increase materially, might be masked by the predominant fan noise. As a result, the noise level of the unit would not increase as much as the constant fifty would indicate. For the average carefully designed fan, test data substantiate the law for ranges much more than the 10 per cent mentioned above.

R. T. Lange, Piqua, Ohio, referred to an application of a 7-in. diameter axial flow fan to a gasoline-fired type of unit heater, which he had tested under standard conditions and asked whether a standard test code had been used in making the tests reported by Messrs. Troller, Criqui and Heath. He stated that tests of the 7-in. fan made at 12,000 rpm for single, two-, three- and four-speed units with various type guide vanes had shown efficiencies varying from 58 to as high as 87 per cent.

R. D. Madison, Buffalo, N. Y., in answer to a question as to how such high efficiencies could be obtained by axial flow fans, attempted to show by means of diagrams how the space between airfoil blades could be likened to a curved diverging channel. In ductwork it is difficult to get air to flow efficiently around such a channel. However, the air passing around each airfoil shape attains a circulation component which furnishes the turning movement required. Thus, what is inefficient flow in a single diverging elbow may become a very efficient flow through the blades of an axial flow fan.

Harry Schmidt, Caldwell, N. J., referred to the difficulty of providing a simple mechanism for changing the pitch of the blades of axial fans and suggested that a speed control of the fan might be used to advantage. He asked the author whether velocity contours taken at the entrance of the fan might not indicate the cause of the noise produced by axial flow fan.

W. H. Carrier, Syracuse, N. Y., referred, as a matter of interest, to an axial flow fan installation in a wind tunnel at Cleveland.

In this installation the fan is driven by a direct connected 20,000 hp motor and supplies 10,000,000 cu ft of air per minute at a static pressure of 10½ in. The anticipated efficiency will be 85 to 87 per cent.

Y. S. Touloukian, Cambridge, Mass., asked what effect the boundary layer would have in eliminating noise?

Author's Closure: All fans tested were conducted under standard test conditions. In my opinion it will be possible to build axial flow fans with adjustable pitch at a reasonable cost. While speed changes would be advantageous one difficulty, up to the present time, has been lack of good available means of changing a-c motor speed. As improved means for speed change become available the decision regarding advisability of using either variable pitch or a change of speed would depend upon the cost and the adaptability of the method.

By eliminating the boundary layer it becomes possible to use higher pressures which may make it possible to obtain a given static pressure requirement with a lower fan speed. The lower fan speed under certain circumstances might produce less noise. The existing noise level in a conventional fan can be traced partly to the existing pressure field about the individual blade, relative pressure changes, and the total velocity existing about these pressure coefficients.

Fuel Economy and Army Heating

By Major Arthur W. Nelson, C. E.

COAL IS AMMUNITION—DO NOT WASTE IT. Around this slogan the Army built a program of coal economy and this program is getting results. The Army places great emphasis on economy; economy of material and economy of manpower.

This paper will cover only three aspects of the coal economy program as it has developed at the large camp at which the author is stationed:

1. The magnitude of the engineering problems incident to the Army's coal economy program including certain allied features of economy.
2. The results obtained at a central heating plant from a coordinated instrumentation and coal economy program.
3. The mass training of soldier furnace firemen in proper firing and operation of a critical type of heating system.

A large Army camp is a city of hastily constructed frame buildings which have high heat transmission coefficients and abnormal infiltration. Its heating and power plant problems exceed those of a city. This paper pertains to a camp at which over 100,000 tons of coal are burned annually and in which the objective is a saving of 10,000 tons. Coal is burned in 4000 to 5000 systems which include tank heaters, space heaters, cooking ranges, mechanical warm air furnace systems, several boilers under 100 hp, a dozen or more boilers over 100 hp but under 300 hp, a central heating plant for a 2500-bed hospital, and also two 500 bhp laundries with equipment driven by horizontal steam engines.

Boilers of 100 hp and over are fired by Civil Service personnel, while other heating systems, in general, are fired by soldiers. The maintenance and repairing of all equipment, however, are the responsibility of the Post Engineer and are handled by Civil Service personnel. The training of all soldier furnace firemen is also the responsibility of the Post Engineer.

New England has a rugged climate. Fig. 1 shows the degree-days at this camp for the 1942-43 heating season and for the 1943-44 heating season to January 1.

The program for securing economical operation of heating equipment is not limited to improvement of combustion and reduction of heat loss. Emphasis is placed upon the type of operation which will prolong life of grates, firebrick, controls and combustion chambers. Attention is given to cleaning of air filters, flue pipes and stacks as a contribution to over-all economy. Stress is placed upon the Btu lost through the excessive use of hot water which causes a waste of both water and coal.

Preventive maintenance anticipates breakdowns and service interruptions and tends to curtail or eliminate later excessive repair replacements. Heating systems must last for the duration because repair parts are difficult or impossible to obtain. There is a ratio between the importance of preventive maintenance and the age of equipment. Technical assistance has been made available by the Office of the Service Command Engineer, First Service Command, which has supplied charts on preventive maintenance as visual training aids forming a basis for instruction and operation in the field.

In the search for economy which has been broad in scope an attempt has been made to develop in key personnel an attitude of mind which would lead to a constant search for cheaper methods of providing heat. The Post Engineer has been issued several hundred economizers for installation on space heaters. Buildings have been winterized and sealed skirting has been installed to reduce infiltration below first floors. Interior insulation, storm windows and storm porches have been added where warranted. A few months ago a large program was completed involving drastic changes in duct work in certain types of buildings which use mechanical warm air furnace systems. These changes were made only after exhaustive tests had demonstrated their feasibility. As a result it was possible to reduce velocities, eliminate drafts at floor levels to a large extent, save fuel, and, of equal importance, to establish healthier heating conditions. Recently tests have been made in the use of lower cost, higher Btu content coal in certain types of heaters. Tests are being conducted in the burning of mixtures of bituminous and anthracite coal.

No aspect of the Army operation is too insignificant to warrant study and consideration. Mechanics are given *on-the-job* training and work simplification is stressed.

A competitive spirit is aroused

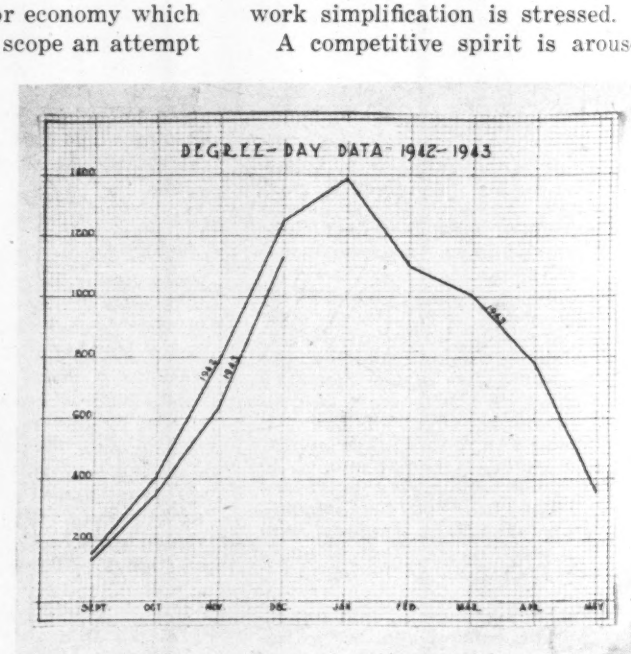


Fig. 1—Degree-days at camp for 1942-43 and 1943-44 heating season to January 1

Presented at the 50th Annual Meeting of the American Society of Heating and Ventilating Engineers.

by blocking off areas in which the mechanics are charged with responsibility for maintaining efficiency and are rewarded by promotions for efficiency and economy as demonstrated by records maintained. Usable material such as extra fittings and pipe are carefully saved for future use.

A safety program is being promoted constantly. Mechanics are trained to maintain tools and equipment in safe, workable condition. The threads on pipe wrenches are kept sharp, and bits for pipe cutters, dies and taps are maintained in proper condition.

Hospital Central Heating Plant

The hospital central heating plant consists of 3 cross drum water tube boilers and 2 inclined longitudinal drum boilers having a total rating of 1650 bhp, which at 100 per cent of rated capacity supplies 272,000 sq ft EDR, including domestic hot water and steam for sterilizing. The steam gage pressure averages 90 psi, the feed water temperature averages 220 F. The stack averages 550 to 600 F. These boilers are fired by conveyor feed ram-type stokers, with counters attached, and are equipped with soot blowers and combustion controls. A boiler water treatment program is rigorously followed and has been successful in almost completely eliminating incrustation.

The Office of the Chief of Engineers, Army Service Forces, has sponsored an instrumentation program reduced to the utmost simplicity in order to be workable, which saves critical materials. Adequate measuring instruments have been provided for determining the quantity of steam and fuel consumption. The boilers are equipped with comparative instruments for the purpose of obtaining more uniform, efficient operation. It is being demonstrated that the proper use of these instruments, together with proper analysis and interpretation of data obtained, assists in making corrective adjustments and changes of method which secure economical combustion. The instrumentation program is providing a yardstick to measure efficiency of our operating personnel. It has been found possible to stimulate interest on the part of the operating personnel and encourage them to meet increasingly higher standards of operating efficiency.

The Post Engineer and the Chief Engineer make periodic visits to the central heating plant for consultation with the operating engineer and for study of the records produced. The operating engineer keeps a constant check of air pressure in the windbox, combustion chamber draft, draft in the last pass and takes CO_2 samples as a check on the accuracy of the recording meters. The use of instruments is reducing the cost of the finished product.

When a boiler is taken off the line for a complete check-up, the interest of the operating personnel is stimulated when the Post Engineer and the Chief Engineer inspect the grates and refractories, explore the inner recesses of the drums, and make minute inspection of the skin. The importance of boiler water treatment can best be emphasized by crawling into a boiler drum and observing scale conditions. This experience is far more real to operating personnel than an analysis of boiler water samples and is sure to create an impression of the importance of the instrumentation program. The Army is serious about operating efficiency.

The instrumentation program includes both the indicating type as well as instruments making continuous recordings on charts. When using the former, a log by watch is kept showing feed water temperature, windbox pressure, draft over the fire, draft in the last pass and pounds of coal used per watch. In addition, information is recorded pertinent to blowdown, boiler treatment, soot blowdown, outside temperature, and degree-days.

Recording instruments show stack temperatures, steam pressures, and the ratio of steam flow to air flow on charts. These instruments are equipped with steam integrators showing steam produced for any given period. Efficiency tables based on evaporation from and at 212 F are utilized.

The intricacies of thermodynamics are eliminated in boiler room discussions. Problems involving enthalpy are worked out by the Post Engineer and the Chief Engineer. Operating personnel can be shown the relationship of a clean fire and a good CO_2, as well as the relationship between a fire with holes and clinkers and improper combustion. The relationship between excessive air and a high stack temperature is registered visually on the steam flow-air flow chart and the stack temperature chart. It can be demonstrated that it is more economical

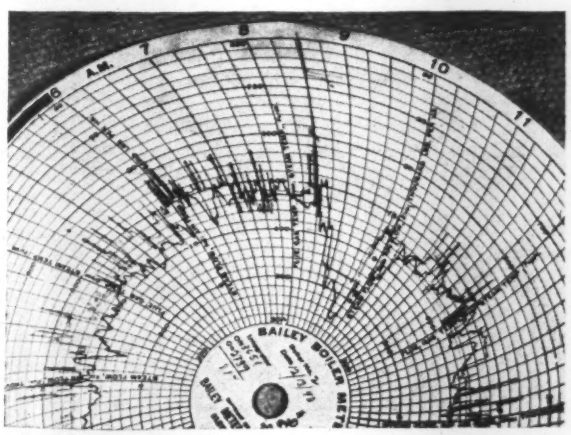


Fig. 2—Steam-flow air-flow chart, December 13, 1943

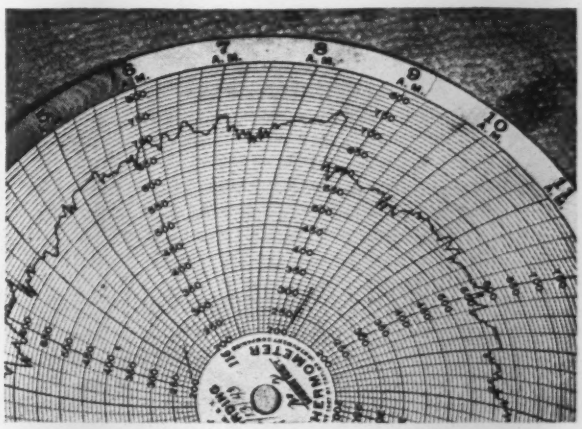


Fig. 3—Boiler stack temperature chart, December 13, 1943

to force boilers above rated capacity than it is to add another boiler and operate them at a fraction of capacity. The ratio of pounds of steam generated to pounds of coal burned is fundamental. An endeavor is made to show the simple relationships between cause and effect and as a result of keeping explanations simple, the whole-hearted cooperation of the operating personnel is obtained.

Figs. 2 and 3 show the relationship between improper combustion from 6 to 9 a. m., as reflected on the steam flow-air flow chart, and a high stack temperature recorded on the stack temperature chart. It will be noted that at 8:30 a. m., after clinkers were removed, the fire raked, and soot blown, the stack temperature dropped to normal and the steam flow-air flow lines became parallel.

While control of central heating plant efficiency has been obtained, it constitutes only part of the problem of securing economical operation and is less difficult to obtain than is elimination of waste in heat distribution. The cooperation of hospital personnel is essential and unless it is obtained by constant attention, the operation of central heating plant economies may be dissipated by maintenance of excessive ward temperatures.

Training of Soldier Firemen

At the present time over 1000 mechanical warm air furnace systems are being operated and maintained at the camp for heating barracks, office buildings and warehouses. During a heating season there is a turnover of soldier furnace firemen of 200 per cent to 400 per cent as several thousand soldiers are trained each heating season. Instructing and training soldiers into the proper methods applicable to mechanical warm air systems constitute the major items in the furnace fireman training program. Training soldier firemen for firing 1600 space heaters and over 1000 Army No. 5 Coal Ranges provides a similar problem.

It became apparent three years ago that this training program must be simple. It was found that lectures on the chemistry of combustion had no direct bearing on the subsequent number of burned-out or broken grates. The training system has been short-cut and simple but it works and the schools are never-ending. Several thousand soldiers have been instructed on proper heating methods. The Camp Commander cooperates and has ordered that no person shall fire a mechanical warm air system unless he has been trained and certified by the Post Engineer Organization. The soldier furnace firemen training system is built around the concept of inspector-mechanic and, in turn, is based on the technical training of high-grade stove and furnace mechanics. The inspector-mechanics are assigned to certain areas or blocks in which each inspector-mechanic is responsible for from 50 to 100 units. The inspector-mechanics quickly discover cases of improper firing which, if neglected, would result in burned-out grates and combustion chambers.

The present system of training soldier furnace firemen follows closely the Army system of instruction in basic subjects. It is a standing operating procedure. It consists of four distinct steps, as follows:

1. Explanation of the subject or action by the instructor.
2. Demonstration of the subject or action by the instructor and his assistants.
3. Imitation (application) by all undergoing instruction.
4. Correction of errors by the instructor and his assistants.

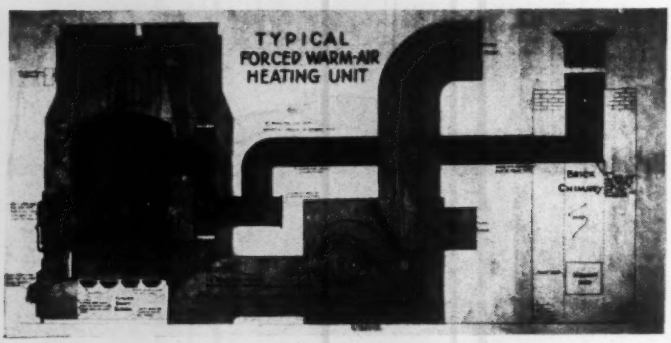


Fig. 4—Diagram showing air circulation in mechanical warm-air furnace system

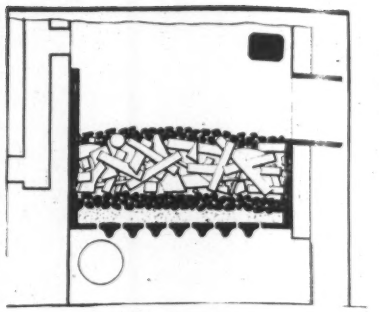


Fig. 5—Proper method for starting a fire

It is believed that the best place for instruction is the furnace room, where the instructor performs each step slowly and accompanies his actions with a detailed explanation. The soldier trainee is then ordered to imitate every movement and action previously made by the instructor. Assistant instructors check the correctness of the trainee's actions. Simple, routine, one-two-three-four type of procedure in slow motion is followed. The Post Engineer has been given invaluable assistance by the Office of the Service Command Engineer, First Service Command. Training aids have been provided in the form of cut-away models, large charts, clear-cut simple instruction cards. Cut-away pictures are used to show the right way and the wrong way and the disastrous results of improper methods are graphically demonstrated. A lecture, so simple that its fundamentals can be grasped quickly, has been prepared for use with the pictures. It explains the responsibilities of the furnace firemen and refers to the critical shortage of coal and waste of critical materials resulting from incorrect firing methods.

The principles of operation of a mechanical warm air furnace system are described in the lecture. A

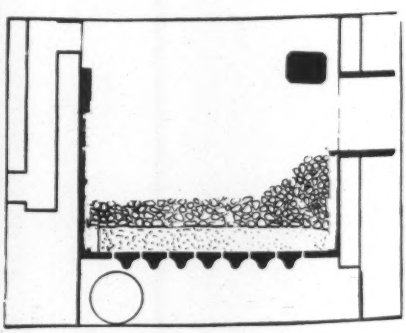


Fig. 6—Proper shape of fuel bed before adding fresh coal

cut-away model as shown in Fig. 4 is used to illustrate the circulation of air from the barracks through the air filters, through circulating fan, around the combustion chamber and heat exchanger, through the furnace dome, past the furnacestat and up to the barracks again. The soldier furnace firemen are ordered not to tamper with any of the controls and not to endeavor to adjust the air shutter on the forced draft blower. They are ordered to report immediately any controls which are not operating properly or any firebrick or refractory requiring replacement or repair. Fig. 5 shows the soldier furnace fireman how to start a fire.

Soldier furnace firemen are told in plain language how grates may be warped or burned-out if improper methods are used. They are shown why it is necessary to turn off the forced draft fan while starting the fire. Fig. 6 illustrates how to rake the coal before adding fresh coal so that a red spot will always be showing after adding coal. The necessity and reason for this red spot is emphasized. The necessity for keeping a clean ashpit is strongly stressed. Many other illustrations are used to indicate proper procedure and the results of improper procedure.

As a partial result of this simple training system there has been a startling reduction in the number of burned-out and broken grates and a reduction of combustible in the ash. The training plan has been successful. It is a highly important factor in the coal economy program —*Coal Is Ammunition — Do Not Waste It.*

Conclusions

1. It has been determined that to be effective an economy program must be broad in scope, encompassing all phases of the operation; *i.e.*, economy of coal, conservation of critical material, and equipment, and economical utilization of manpower.

2. Effective economy in a central heating plant is contingent upon complete and accurate data. Instrumentation of the boiler room provides necessary information for analysis. Resultant corrective adjustments and necessary changes in methods coupled with the stimulated interest of operating personnel lead to higher efficiencies and lowered coal consumption.

3. The standing operating procedure for basic military training has proven to be the most efficient method of mass training for furnace firemen. A high degree of indoctrination of basic principles, a minimum of training time, and a decreased teaching staff are a result of this method.

Acknowledgment

The author is indebted to his Chief Engineer, Alfred C. Anderson, for his collaboration in certain studies of problems. The solutions of these problems lead to the economies that provide the basis for the central heating plant section of this paper.

The author is considerably indebted to the engineering staff of the Service Command Engineer, First Service Command, for technical information and data presented at a recent Post Engineer Conference at Boston, Mass.

MEMBERS ENJOY SPECIAL EXHIBIT

An unusual and very successful feature of the 50th Annual Meeting of the ASHVE at Hotel Pennsylvania, New York, N. Y., January 30-31, February 1-2, 1944, was the New York Chapter room in which Charles F. Roth, Chairman of the New York Chapter Special Committee, had assembled and arranged an exhibit depicting the progress of heating, ventilating and air conditioning during the existence of the Society. Text books even older than the Society, manufacturers' catalogs, several ancient heating devices, a review of the development of air conditioning, interesting drawings and plans loaned by members, photos of all Society presidents, a collection of Transactions for the 50-year period and a complete set of ASHVE Guides were on display.

The Committee was highly gratified by the cooperation of many individual members and firms in lending material for this exhibit.

"Old Timers" at the 50th Annual Meeting in New York—How many do you know?

Collective Bargaining for Engineering Employees

By George T. Seabury,* New York, N. Y.

Address delivered at Society's 50th Annual Meeting, Hotel Pennsylvania, New York, N. Y., February 2, 1944

BEFORE I enter upon the subject on which you have asked me to speak this morning may I say a word of congratulation to you upon the occasion of this celebration of the 50th Anniversary of the founding of your Society? No organization can continue for 50 years unless it has done something, and is continuing to do something, that is good and worthwhile. May I wish for you many continued years of those good and worthwhile accomplishments.

The subject on which I am to talk is quite different from that of the preceding one which was of a technological character. Mine has to do with a sociological problem. It will be my effort to give you an understanding of the approach to collective bargaining for engineering employees as it has been seen by the members of the Board of Direction of the *American Society of Civil Engineers*—to tell you what they have done—why they did it—and the reactions induced.

I can tell you right now that there are varying reactions. There are high hopes on one side and deep despair on the other. There is a conservative attitude and there may be something of a radical attitude, but I have not seen what I would call a radical attitude. I have seen enthusiasm for the program but I would not call it radical.

The *ASCE* first observed inroads by the trade unions, namely, the C. I. O. and the A. F. of L. into the fields of engineering, more particularly civil engineering because our eyes were focused upon civil engineering, as long ago as 1936. In 1937 we appointed a committee to determine to what degree there were such inroads. That was a rather large committee, composed of men living in all parts of the country. They made investigations to a greater or lesser extent, and found collectively that there were a number of pressure groups, some of them not organized or affiliated with the C. I. O. or with the A. F. of L. and others organized and affiliated with those large organizations.

Thereupon they made a report to the Board of Direction which appeared in our publications as early as 1938. I will not try to read you the whole report but there are a number of statements in it, resulting from observations in 1936 and 1937, which are of some significance.

One is, "Membership in a trade union is primarily an economic matter. Therefore, the *American Society of Civil Engineers* should consider such membership as having no more bearing upon a man's qualifications for membership in the Society than have his religious or political affiliations."

Another comment has to do with the Wagner Labor Relations Act, which, it was stated, "has encouraged the extension of existing unions, and the formation of others, it has paved the way for complete unionization of the employees of many industries, and may be expected to result in the formation of collective bargaining groups in all plants and offices where any considerable numbers of men are employed. Engineers and architects, as well as draftsmen and other subprofessional men, are not and cannot be exempted from the provisions of the Act."

Another portion of the report goes on to say that, "Extension of unionization to include a large part of the employees of some industries and its possible extension to many other organizations has made it desirable in some instances for engineers to organize to protect their own rights. In other instances engineers have organized or have joined existing trade unions in the belief that they can better their economic position thereby. These existing trade unions are far from ideal to represent engineers in collective action. Experience has shown that such action can be taken by engineers themselves without resort to strikes and other trade union tactics. Therefore, on the assumption that the need for facilities for collective action by engineers will increase at least temporarily in the future, the Society should stand ready to cooperate with other societies or with state organizations in the establishment of temporary or permanent agencies to represent engineers in collective action in a dignified, professional manner whenever necessary."

The matter has therefore been discussed as long ago as 1937, and in 1941 a resolution was addressed to our Board of Direction by one of our Local Section Conferences. That resolution reads this way:

"RESOLVED, That the Board of Direction of the Society shall establish a policy on a nation-wide basis for the Local Sections to follow in the matter of unionization; that it shall promptly formulate and put such a policy into action."

Following that recommendation the Board of Direction two years ago today or thereabouts directed that a staff member be engaged who would spend his entire time considering this problem and determining to what extent it was inimical to the interests of professional engineers.

First, he studied the Federal labor laws, particularly, of course, those of more recent date, which have to do with hours and wages and those which have to do with collective bargaining and the rights that are accorded to employees with relation to their employers through the medium of collective bargaining.

He has made quarterly reports of a confidential nature to the Board of Direction, so that the Board members have been pretty well in-

*Secretary, *American Society of Civil Engineers.*

formed. Experiences have been met in several places where members of the *ASCE* have found themselves uncomfortable in the approach which is being made aggressively and more intensively of late—the approach made by the A. F. of L. and the C. I. O. sub-unions or sub-organizations. Of these there are two special groups which apply to architects, engineers, chemists, draftsmen, and technicians.

In one particular instance the situation was as follows: This staff member, in passing through in his search for information, discovered that, at an ordnance plant—the so-called Sunflower Ordnance Plant being built in the vicinity of Kansas—there was growing a large, well-organized group of people in the engineering field who had formed themselves into a union affiliated with the A. F. of L. He thereupon told some of the more professionally-minded civil engineers working in that plant—and I think I can indicate to you in a moment the difference between those who were in the union and those of whom I am speaking as professionally-minded. He told them about it. He told them, "There is a union here, and, if you don't watch out, you are likely to be forced to join that union."

Time went on and nothing was done, although the professionally-minded people talked their situation over more or less. But nothing was done. The union was recognized, and here I will try to define that union. The particular engineer in charge of that job, that is, the so-called *Architect-Engineer* who had a contract to design and supervise the construction of the job, had, I understand, more than fifty field parties doing surveying. Many of the men in those survey parties were never in the profession and never expect to be in the profession except as accident may turn them in that direction. They had not the education for it—no preparation. I think it is fair to say that a good many of them were of the type of the boys who are customarily behind soda-water fountains, and, seeing a chance to get more money during this war excitement, went to the job and were taken on. It is certainly fair to say that, as a group, they were not trained, educated, nor could in any way demonstrate that they had been engineers or were likely to become engineers of the type that you and I would like to think of as constituting the profession.

They brought a complaint against the employer. The employer received that complaint, and thereupon it was taken to a regional labor board. The regional labor board appointed a panel of three men to hear the case. Going before that panel the representative of the union was found to be a *Professional Engineer*, registered as such in the State of New York. The president of the union was also a *Professional Engineer* registered in the State of Washington.

Thereupon, these more professionally-minded engineers, to the number of 115, sought recognition as a minority group in that plant. That, the panel refused, saying it was not on their agenda, and, although it had heard them, it ordered what they had said to be stricken from the record.

Employer engineers in that neighborhood telephoned me and said, "We believe that this is a case where these higher-minded, higher type of men, the more professionally-minded, should be protected," with the result that that member of my staff who had been studying this kind of thing went there. We engaged local counsel and injected ourselves, and properly so, I believe, into the situation, somewhat as a friend of the court. The panel thereupon opened its hearings again and continued them from Tuesday noon, when the subject had been thrown out, until Saturday noon. The panel's report, however, refused the minority group, essentially on the grounds that the union had been recognized a year before and was therefore the proper bargaining unit for all the engineers on that plant. The implication, of course, is that when the union would choose to ask for a closed shop, all engineers, no matter of what quality, must join with them, or betake themselves elsewhere. The professionally-minded engineer, to whom I am again referring in that manner, would find himself, in a closed shop, in the very considerable minority in the recognized collective bargaining unit.

Our Board of Direction, learning of that situation, instructed that we go out and find a place where a collective bargaining group of professionally-minded men could be formed and recognized prior to the formation of a union of the C. I. O. or of the A. F. of L. That we attempted. We went to the National Labor Relations Board and talked over with them, informally, the definition which should apply to these men as separated from the sub-professional type of men who are more easily approached in terms of the trade unions.

We went to the employer where it was proposed that we should form a group of professionally-minded engineers. However, when we got to the site there happened to be a very unusual combination of physical circumstances which really made us back down. We decided that was not a good place to start.

In the meantime, this staff member, Howard F. Peckworth, has been called upon to advise employers and employees in various places, and he has traveled over the country, in considerable degree, advising employees how to overcome their difficulties, and advising employers how to deal with the unions when those employers have been approached by the unions.

Out of it all our Board of Direction stimulated our Committee on Employment Conditions to crystalize for it a program quite in consonance with that resolution which I read to you as coming from one of our Local Section Conferences. That committee did crystalize a program which is defined as having three phases: first, recommending to our Local Sections, of which we have 64, and which cover the entire United States, as well as Panama, Puerto Rico, and Hawaii, that they make provision for collective bargaining groups to be composed of, and for the present to be controlled by, our own members. The committee formulated the draft of a constitution which might be adopted by those several Local Sections, either verbatim or with such changes as would be needed to fit local circumstances. Nineteen of our Local Sections have already adopted the new constitution and it is interesting to observe that the ratio of the votes in the affirmative to the votes in the negative on the

proposal to amend the constitution average for those nineteen, 93 per cent in favor and 7 per cent against.

Now, it may be that the civil engineers are a different type, in some way, from other engineers—not mentally nor intellectually—but in their mode of gaining a livelihood. They generally are engaged in large masses. There are over 40,000 civil engineers in the employ of the Federal Government. A little while ago we made a survey and we knew then that there were 19,000 civil engineers employed in the various state highway departments. We know that very few are engaged in industry. Of civil engineers, the very great majority are employees. Of course, some are employers and some are employees of employers to whom managerial responsibility has been delegated and they have the right to hire and fire. Neither an employer nor a man who has this managerial responsibility and the right to hire and fire may belong to a collective bargaining group. The situation may be different in your Society. Perhaps men working in the field of civil engineering are more susceptible to employee problems than would be those employees in some of the other branches of the engineering profession.

The constitution which our Board of Direction purposed be adopted had the provision that first of all there should be something required in the nature of a *roster* of the men who wished to belong to a local collective bargaining group. Those men would have to be scrutinized as to whether they were of the character (I don't mean moral or religious character; I mean of the intellectual and occupational character) which would entitle them to belong to a professional employee group. Some men would be excluded because they were employers. Others would be excluded because they were distinctly of the subprofessional type, such as I tried to describe in a previous connection. After these men had been identified they were to be called together; employers and men in managerial relationship to employers were to be excluded; they were to elect their own temporary Chairman; they were to select a group of three which would be called a Committee on Employment Conditions and which would act as their agent in collective bargaining procedures.

I spoke a little while ago of the fact that the committee had proposed a three-phase program. The second phase of the program was to determine what would be a satisfactory definition. This was hard to draft and it was with the aid of some of the lawyers connected with the National Labor Relations Board that we drafted a definition which is tentative. It is very probable that when it is placed before the Labor Board for definitive action there will be some changes. Those changes, it is planned, are to be presented to our Board of Direction, and therefore it has been suggested to our Local Sections that they do not include that definition in their constitutions but that they refer to it, thus making it possible for only one body, our Board of Direction, to collaborate with the Labor Relations Board and secure a satisfactory definition of the *Professional Engineering Employee.*

The third phase that was proposed was that the Society place four men in the field to be of assistance in this matter. The placing of those four men in the field can be construed both happily and unhappily. The intent of the Board and the intent of the committee, and, I think, the intent of all those who have voted to change the constitutions is that their engagement shall result in a happy situation. It is quite contrary to the thought of the Board that these collective bargaining agencies shall engage in case after case, problem after problem, with the intensity that some unions have applied, and with the methods which some unions have used in the way of picketing, striking, and so forth. Those four men are viewed as to be conciliators to a far greater degree than they are to be anything else. When problems arise in a neighborhood where the situation becomes perhaps sufficiently intense to use the bargaining agencies, one of these four men, it is planned, should act as a conciliator between the group and the employer. Mr. Peckworth has already done just that in a number of cases, and it is believed that the very large majority of cases will be settled through the conciliation services of these four traveling members of the Society's staff.

Now, the matter has gone thus far, and perhaps I have painted the rosy side of it. At our annual meeting the entire afternoon was devoted to a discussion of the subject, the motion being somewhat to this effect—I shall not try to give it verbatim: "Moved, that the Board of Direction of the Society be requested to reconsider and reverse its decision and to allow all members of the Society to express their opinions by ballot." The matter was discussed for three hours, one of the speakers being Dr. Parsons, Secretary of the American Chemical Society, which has had considerable difficulty in protecting its members from union organizations in connection with work on the West Coast. The problem is more acute on the West Coast, incidentally, than it is in New England, New York, Pennsylvania or New Jersey. It is acute also in the Southern states, around the Gulf.

Therefore, some people saw the recommended procedure with favor and spoke of it favorably at that meeting. Others spoke of it as from a disapproving point of view. The vote taken at the end of the meeting failed to support the motion.

That, gentlemen, is the situation. I have tried, without going into too many details, and taking too much time, to give you the background from which what has been called a *conservative* organization, has taken what appears to many to be an extremely unconservative attitude.

If I may, I would like to explain again that it perhaps is due to the fact that civil engineers are hired in large groups. The City of New York normally has about 4,000 civil engineers in its employ. On some of the war plants which have been built the groups of civil engineers and their assistants have been as large as six or seven hundred men and in one case, I think, even a thousand civil engineers were working on the construction of these war plants.

Of course, those engineers who operate in private practice and in doing so use other engineers to assist them can view this program with alarm and, I may interpolate here, some of them should.

On the other hand, there are many engineers, employers of engineering employees, who treat their men very happily. These men need have no fear of these kinds of collective bargaining groups. It is the employers who need correction who may have the fear.

But, of course, the idea expressed in a Society which, I think I may say, is conservative, and the members of which are all individuals who have been very carefully scrutinized before they come in, in the manner of which our Society is rather proud; of course, in that group there is a high degree of conservatism and there is therefore the opportunity of thinking on both sides of a question.

Mr. President, as far as I can judge, I have given a sort of history, a sort of reason for our Board's action. If you will permit the time, however, I will answer some of the questions that have been asked as to the operations of these bargaining groups.

It has been asked if membership in these collective bargaining groups is to be limited to membership in the *American Society of Civil Engineers*. The answer is *No*, but doubtless some explanation is necessary.

Because we have Local Sections, as we call them, centering in the larger cities throughout the United States, the entire United States is divided into local section areas. These collective bargaining groups, it is our plan, are to be formed in those areas and, first of all, of our own members; then of other persons of the same type, although not necessarily practicing the same branch of the profession. The group then will have other than our members in it. In illustration it might be said that in any State we would have our own members form a group, and then there might be members of, say, the Highway Department of that State who are not members of our Society who may join the group.

Furthermore, if a group should consist, we will say for the sake of using simple figures, of 100 members of our Society, and there should become affiliated with it four or five hundred engineers not members of our Society, there is no question but that as a democratic procedure they, not members of our Society, must be represented in some relative degree on the committee which is to be the agent for the group.

Another question that has been asked is why a new definition of the members of these proposed groups has been drafted when already most of the States have laws providing for the registration of *Professional Engineers*; that is, why could not that term *Professional Engineer* have been considered as satisfying all the characteristics that would be found in one whom I have persistently spoken of as *professionally-minded?* The committee was particularly anxious to refrain from a new definition but found it necessary if all who should be included were to be thus included in one definition.

The laws requiring registration of engineers in the various states vary in wide degree. Some states have no such laws. In others, registration is voluntary only. In most of the laws large numbers are exempted. In others the criteria, even on paper, are low and the application is still lower. There is, in my belief, no real uniformity, at the law level, of the engineers who are licensed to designate themselves as professional engineers. Therefore, there was need for a broader definition.

Also in the registration laws the provisions are so worded that people become registered engineers and may use the title *Professional Engineer* at an age not much less than 27. Almost invariably it is a requirement that after graduation from an engineering school there shall be an interim, or apprentice, period during which experience is to be acquired. That period also varies in the various laws but in most is five years. So that if one thinks of the average age of a graduate as 23, five more years would make him 28 before he may become a *Professional Engineer* in terms of the state laws.

There are on foot plans to correct that situation. In the State of Ohio the law has been changed to permit of what are called *Engineers-in-Training*, and young men graduating from engineering schools are permitted to take a part of the examination. If they pass, they are permitted to call themselves *Engineers-in-Training*. The same situation obtains in the State of New York, except that in the State of New York it is not in the law; it is in self-made rules and regulations by the Board of Engineering Examiners. Thus there are only two places in the United States at the present time which give any legal recognition to a professional attitude, or the professional-mindedness that I have spoken about so frequently, to men unless they have attained the age of 27 or 28.

It is the younger men, below that age; it is the men who are graduating from engineering schools who also should be protected as *professionally-minded* or as *Professional Engineering Employees*. Therefore, although the attempt was made, and made seriously, to try to use the term *Professional Engineer*, it was believed that a new definition was preferable.

It has been asked if there would be any interrelation between *Professional Engineers* as registered under State laws and the *Professional Engineering Employees* who are to make up these collective bargaining groups. I think the answer is that there would be no real interrelationship. As I have indicated, many very fine engineers are specifically exempted from state registration and they should be in these groups. Also employers are registered but may not be in these groups. Also, and this is most important, young men, just graduated, are not permitted, by State laws, to become *Professional Engineers* and certainly they should be permitted to bargain in groups made up of other than those sub-professional men who constitute the very great majority of the technical unions affiliated with the A. F. of L. or the C. I. O.

It has been a pleasure to have been invited to comment upon this problem here to you today. I hope I have left with you at least one thought, namely, that it is the intention of the Board of Direction of the *American Society of Civil Engineers* that its proposal shall be viewed as an effort to assist many members of the engineering profession and to do so in a wholesome and professional manner.

Postwar Era Offers a Challenge to Engineering*

By Hon. F. H. LaGuardia,
Mayor of New York City

I WANTED to come here today to express my thanks and appreciation for the help your Society gave the city when we were first confronted with the fuel shortage. What we didn't know about heating was considerable. I was surprised to find so many who had been operating large buildings who also knew very little about heating. We had to pick up a great deal, and it is rather difficult to keep abreast of the many complicated conditions that developed.

Two years ago we all had to learn how to convert from fuel oil to coal. Just about the time we knew something about it and were doing it, lo and behold! We had no coal! So it is all rather difficult—and now you gentlemen have a great deal of competition. Every two-by-four politician is either an expert on fuel or on heating and ventilation.

What I thought we could discuss today was the postwar program of the city. We know something about that—the postwar program of the Government that is under consideration now, and then, of course, the postwar activities of industry and business in this country. I believe there is a better understanding of the problem at this time than there was following the first World War. We were in pretty bad shape then. When I got out of the Army and back into the House of Congress there were no plans at all, but there was a great deal of confusion. We had a great deal of stock-ticker prosperity, but it was not difficult to see the crash that was inevitable.

I really believe that there is a different approach now and a complete realization that we must be prepared to get busy immediately following the cessation of hostilities.

No one can predict when the war will end. Surely no military authority would, because the surprise element is something that must be considered above all things in prosecuting a war. We do feel that the war will end in Europe before it ends in the Far East. If that occurs, it would create a period of transition that may affect us considerably here in the East.

Now that a large percentage of the war activities is centered in the East and the need for all supplies, materials, weapons, etc., is at its peak, the cessation of hostilities in Europe may change our situation here by transferring certain activities to the western part of our country, and, in all likelihood, freeing a great deal of material for civilian use.

The New York City program is geared to meet such a situation, and we are ready to start construction of our public works program as soon as materials and labor are available. To what extent we can plunge into our program depends, of course, upon just what the Federal Government may do. I will explain that in a moment.

When I first assumed office on January 1, 1934, I found that the Federal Government was ready with grants and, naturally, I wanted to avail the city of the opportunity and looked around for public works that could qualify. I had been thinking about it even before I became Mayor. Around '35 money was available. I had taken a chance that it would be available, and we had gone forward in the preparation of working plans—complete working plans. In some instances I did not really have the authority to do it, but we managed.

For instance, one of the fir grants that was available was fo housing, and they had been fussi around with it for quite a while. A that time it was lodged in the D partment of the Interior, and Ha old Ickes had control. He had a l of experts here in New York loo ing around, making surveys an doing all sorts of other things. We Mr. Ickes is not the most patie man in the world, as you know, an I am the most patient man in t world, so we have always hit it o splendidly. Mr. Ickes is a ve splendid public official. We fuss around for months, and finally h said, "Now, look here, if you ca get title to the land in 30 days will give you the money for th first project." I think it was abou $25,000,000.

Well, you don't pick that muc money up every day, so we wen out and condemned the land.

Now that it is over and the buil ings there, I can tell you about i If something had happened to M Ickes or if something had gon wrong with that appropriation, don't know what the Mayor woul have done with that land or wh could have paid for it. But we g away with it! We had the land an we transferred it to the Housin Authority. Mr. Ickes paid for i and that was the first housin project—Williamsburg Houses. Th second, Harlem River House wasn't quite so difficult, becaus there we negotiated for a sa which both parties had agreed t At that moment the lawyers g busy and, of course, then the wasn't any agreement. We had t go to condemnation to fix the valua tion.

We could have crawled out o that one, I think.

Next was Brooklyn College— there I hired the architects. didn't have anything to hire the on, and I was pretty sure if the were to sue me personally the couldn't have collected, so tha wasn't so hard.

The point I am trying to make i

*Address delivered at 50th Annual Meeting of American Society of Heating and Ventilating Engineers, Hotel Pennsylvania, New York, N. Y., Jan. 31, 1944.

at we were ahead of all the other ities. While I was the subject of iticism because of the large nount in grants that I was able obtain for New York City, it s only because we were ready fore the other cities.

I can tell you now that it is no cret: we are now ahead of every her city of every other state and the Federal Government in the eparation of plans. They are com-ete, detailed working plans with ecifications ready to advertise for ntracts as soon as the proper me arrives.

To that end, this is the way we ve worked it: we have not ap-oved or authorized any construc-on of any public improvement that not necessary or that could not justified. There is not a single em that is a hobby or authorized r the sole purpose of spending oney. The city has appropriated mething like $30,000,000 for plans ly, and we will have on the shelf mplete plans for something like 00,000,000 of construction. That es not include the five or six low st housing units that are on the ogram and for which funds are w available. It does include hools, hospitals, courts, police and e stations, sewage disposal, sewer stems, parks and playgrounds, ghways and street improvements. he program when completed will ake our city as near perfect as ailable resources would permit. h, we could do much more if we d more money!

A great many of my colleagues other cities have spoofed me bout it and have said, "Well, a Guardia—showing off all the me about your postwar program! here are you going to get the oney?"

Well, I don't know. I am not go-g to worry about it, but I know e money is going to be forthcom-g. I don't care how large the ederal Public Works program may , and it makes no difference, gen-emen, how large the postwar pub-c works program of the entire ountry may be; I am so confident at it must be met because of the onditions with which we shall be onfronted. My only fear is that any states and most cities, and erhaps the Federal Government, ill not be prepared to start this public works program in time to do the most good.

Our program is geared to start so that we can employ at the peak 200,000 men working on the job locally. Now, your guess is as good as mine as to how many men that will employ back of the line. It varies all the way from two to twelve. Some construction, such as ordinary highway construction, won't have as much; other construction will have more; but, at any rate, our program is geared to reach a peak of 200,000 men at one time.

The President has been urging Congress to provide funds for this planning. Well, they have lost a lot of time on that. You would be surprised to know how many people in important positions think of planning as a list of desirable projects with perhaps a rendering of a picture or two, an architect's sketch—and they think that is planning. As a matter of fact, you know it will take a year or a year and a half to complete the detailed working plans for any worth-while structure.

At the moment I think we have about 26 per cent of our plans fully completed. It was not an easy matter to put this program in operation. We met all sorts of opposition. Take our own school program, for instance. There, in order to have this shelf ready—I think it is some $109,000,000 of new schools—I authorized retaining consulting architects for certain schools, and the Civil Service employees of the Department of Education took us into court—sought to enjoin the retaining of outside architects on the ground that their jobs might be jeopardized five years from now! The program to them wasn't of paramount importance at all! Their jobs were what was important, and therefore they wanted all of it no matter how long it might take. We prevailed in that action, fortunately, and we are now retaining outside architects for schools, as well as for a great many other buildings and structures.

The Committee on Public Lands and Buildings is considering the federal postwar program and its members have been holding hearings. I expect to appear before them tomorrow morning. Speaker Rayburn has appointed me on a special postwar study committee to the House of Representatives. Just how the two will overlap I don't know yet, but at least Congress is now giving active thought to it. What Congress should do is to appropriate at least $300,000,000 for plans, that is for detailed working plans, and that wouldn't be too much if a postwar public works program is to have any effect upon the labor situation and the general industrial situation.

You must bear in mind that war production will cease rather suddenly, and on top of that you will have demobilization—not all of the entire force now in the armed services, but enough to be felt. With these men demobilized, something will have to be done, and it will be much cheaper if we do it constructively and intelligently rather than if we are not ready and have to take care of the situation through relief and other similar methods. We found that very expensive and unscientific in the last period of necessity.

You men have a very large interest in this postwar program. It is a challenge. Of course, engineering has progressed so rapidly within the last few years, within the last half century, that if you stopped and did nothing, it would still take the government quite a while—25 years or so—to catch up with you.

When you develop something or a new idea is conceived, you can go ahead and develop it. We have to plug along in exactly the same manner that we did a hundred years ago. There are many things that I think we could do to keep abreast of science, that we are not permitted to do, but we are making some headway; not much, perhaps, but some.

Along with heating and ventilation, I think the time is not far distant when you will take in another branch of engineering that is rapidly developing, and that is cleaning. You will find a more artistic name for it, I am sure, than just "cleaning," but that is what it is. That is developing very rapidly, as you know, and is very closely related to ventilation. What I fear a little bit and what I shall be criticized for, but there is not much that we can do about it now, is that between the time that our plans are

being prepared and the time they will be completed, there will be new methods that we could not have foreseen. We know that there are methods that have been developed and are not released at this time.

I want to ask your interest and help in that and also in breaking down resistance which I have to meet all the time. You won't find much resistance in any construction that is under the control of the executive of the city, because if there is any resistance there, I can remove it. But there are other departments in which it is not so easy. All the outside architects that have been retained are assumed to get the services of consultants in every branch of engineering which might enter into the particular type of work they are doing. We want the last word in heating, in ventilating, and in cleaning included in our shelf of plans.

There is one handicap that I really do not know how to overcome. We are not permitted to purchase or to acquire patented articles or anything that is patented. That whole theory of law was developed and I believe was necessary at a time when there were great abuses. So in the preparation of your specifications for public works be very careful to draw them so that you ask for a given result or objective, leaving it open for others to compete. Then when it is open to competition we will not be prohibited from buying or acquiring a device or article which happens to be patented.

I got into a great deal of difficulty in the early part of my first term in the purchase of pumpers for the Fire Department. What had been going on previously was the other extreme. The particular manufacturer who had the inside track with any particular administration would be the one who would draw the specifications and, naturally, he got the contract. Well, when I came in we had to buy some equipment. I naturally asked about who was drawing the plans and specifications, and the Fire Commissioner looked at me (he had been in the department for over 30 years) and said, "Do you mean to say that we can draw our own specifications?"

I said, "Sure."

"Do you mean to say that we can really do that?"

I said, "Sure."

He said, "I didn't know that."

I said, "All right. A great many things are going to be new from now on. Whom have you got to do it?"

Well, do you know they had no one in the Department who was able to do it! We had to go around fishing into M. I. T. and other places. When we drew our first specifications we were taken into court, and we had to go all the way up to the Court of Appeals and back on that one. That happens very often.

You must guard against that, particularly in schools. I haven't got very much to say about that. You know, a little knowledge is bad. So they know all about it. But there it seems to me we want the last word in ventilation and in heating, and in heating, of course, we want to take advantage of any new fuel—pulverized coal or any new system of the use of fuel that is available. That is why I stress the necessity of having consultants retained by the engineer or the architect who has the responsibility for the city in any given project.

Some of our projects are very large. I am hopeful of developing the primary terminal market in lower Manhattan, and that project is of great magnitude. There we shall need the last word in mechanical appliances for the handling and loading of foods that come to that market.

The new airport is so large that there is nothing that can be compared with it, and that creates a new problem in lighting—one that is most challenging, as it includes not only illumination for the field but also for the hangars and for the appointments in the field.

Then we have a series of new hospitals that also are entitled to the very last word in heating, lighting, and cleaning.

I think you will know within a few weeks just what the Federal Government is going to do, and if it comes through with what the President has in mind (and, of course, this is not confidential information; he has made public statements several times), it will be a program running into the billions of dollars. Nothing short of that would be felt.

Now, if you start to consider that no matter how ambitious a Federal, state, or municipal public works program might be, no matter how gigantic in its proportions, we could not possibly need more than about thirty days of the cost of the war to keep the program going for one year. At this time the Fourth War Loan drive is on. The Government is asking for 14 billion dollars. Why, that pays the cost of the war for less than three months. Actually only about two months plus ten or twelve days.

Now, if a country must spend 100 billion dollars devoted to destruction, tearing down, and killing it is not unreasonable to ask for 10 billion dollars to help in getting back to normal peacetime conditions—ten billion dollars that will build things devoted to protecting life, to improving health, and contributing to the happiness of the people of the nation.

That billion dollar rate will have to be continued for a period at least as long as the war lasts and for a period afterwards. It will give heavy industry a chance to keep going while business and industry convert back to peacetime production.

The immediate postwar period we must understand and be ready to face. There are two ways of doing this. One is the intelligent, well-planned, thought-out approach of first creating and stimulating employment, and then accepting an adjustment to our economy that will meet the new situation. The other is to take a chance, as a great many of our good banker friends tell me, "Let's win the war first and then see what happens."

Well, you can't do that any more. We know what is going to happen. One thing is certain, that men and women will refuse to go hungry if employment is not available through no fault of their own. Another is that we have learned what can be produced to destroy and kill, and intelligent people will refuse to accept any excuse that it cannot be produced to protect life. Not only in our own country will that be true, but it is going to occur in every country. If we are not ready

we shall have turmoil and discontent, confusion, and trouble. We don't want that. We don't want it because we know it can be avoided, and it should be avoided.

It is the men who have been creating things, the men who have been confronted with realities, who will have to do the job. I hate to say this, but the lawyers can't do it; the professional politicians can't do it. You men who are fortunate enough to have prepared for a useful, productive profession and the scientists are the men who will have to solve this problem. It cannot be done by amateurs. It cannot be done in poetry, because you can't eat a poem.

Our task in this country is so much easier than is the same task in any other country of the world because we have the resources. Centuries from now it will be said to our everlasting disgrace that we went through a crisis, a period of unemployment and hunger, a depression when we had surpluses in our country. You can't explain that away. Our production now is greater, and we must apply the God-given resources of our country to the benefit of all our people, and take that surplus which we may have and use it to the benefit and best advantage of other people in exchange for things which they have and which we need.

There are enough natural resources in this world for everybody. That is so true of our own country, where we have more than we need of most of these resources, that I am not pessimistic about the future. It will work out all right. But what you and I have to do—we who have but a brief period of usefulness—is to do our part in filling that gap in the transition period, which may be a very difficult time.

We have the genius. We have the courage. We have the resources. Let's go! That's all. (Applause.)

The War on Four Fronts

By Dr. Daniel A. Poling,* Philadelphia, Pa.

Address delivered at Society's 50th Annual Banquet, Hotel Pennsylvania, New York, N. Y., February 2, 1944

WE ARE winning the war but the war is not won, and until it is won it could be lost.

Of the last twelve months I have spent nearly seven overseas, and in that time have visited all the active fronts, but not all the sectors in England, Africa and Asia.

I tell you tonight that the war will not be lost by the armies of the land and by the ships of the sea and the air. It will not be lost by our sons over there. That issue will be decided by us over here. The war will not be won in the Year of Our Lord 1944—nor ever—by captious criticism of leadership, by slowdowns and strikes and lockouts; nor by any plan for appeasement or selfish nationalism—not now, or ever. Now minutes are men. Presently they may be your man.

Two years ago the President of the United States said, "This is a new kind of war, and it is a new kind of war because ours is a new world."

There appeared recently a book which is of interest describing the journey of a former Philadelphian from Philadelphia to Williamsburg, Va. He was eight days in the saddle and he had some strenuous adventures.

Dr. Daniel A. Poling
Philadelphia, Pa.

In December I spent eight days flying back from Chungking to Philadelphia, and of the eight days I was on the ground three; yet I traveled 16,000 miles.

This is the new world in which we live. I crossed the Atlantic Ocean first in December, 1917, when many others were crossing. I spent 13 days at sea on the old New York of the United States Line. I saw plenty of ocean. I flew the Atlantic first in September, 1941, before Pearl Harbor, without even seeing the water. We took off one night from Gander, in Newfoundland, went up through the fog and mists that came booming down the Straits of Labrador, came out at 17,000 ft under the stars, stayed there for 9 hours and 10 min, and dropped down through fog and mist to a happy landing in Scotland. We had not seen the water.

Lt. Reynolds stepped from the B-24, stretched his cramped legs, and said, "I have enough gas to get back to Chicago." I think that was an exaggeration, but he had gas enough to get home.

Twenty-five years ago, when some of those of us who are now venerable men, watching our arteries, were younger, the oceans divided the continents. Now they do not interrupt our passage over them. Twenty-five years ago the ether above us was friendly. Now it is a sea filled with potential fleets of death and destruction.

It is a new kind of war because it is a new world. Years ago I read an article in the Scientific American which said that the time would come when a man could ground his instrument and talk to his friend who might be lost in a jungle of Africa. I didn't know what it meant to *ground* an instrument, and I didn't believe it, anyhow; but I have lived to do just that.

In 1938 I found myself in Honolulu, visiting a friend who is a short-wave enthusiast, and one evening he introduced me to a friend of his whom he had never seen, who has a great sheep station in Northern Rhodesia, in Africa, and he said to his friend as they sat in conversation, "My friend, Dan Poling, is coming out there in a few

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months, and I hope you two men meet." It was as simple as that. A few months later I came down to Bulawayo, the capital of Southern Rhodesia, from Victoria Falls, and the gentleman met me and took me out to World's End, where I saw the grave of Cecil Rhodes, then took me to his station, and that night I talked to Philadelphia! The arrangements had been perfected, and I whispered across the world, or through it, or around it; I talked on Friday and was heard on Thursday. The international date line took care of that!

Yes, this is a new kind of war because we live in a new kind of world. Last March I spent two weeks in the Midlands with some of our bomber squadrons. I was preparing some short articles then for the Philadelphia Enquirer. I called them, "A Preacher Looks at War," and I saw plenty. I was with the briefings in the morning, and then I would stand with the chaplains of the two faiths while the great ships would take off the ground—crews waiting on the field. When the time had elapsed, we would go to greet them as they returned.

One evening—it was the evening of the day when we suffered our heaviest bomber losses up to that time—when the great ships came in I found myself afterward at headquarters. A lieutenant-colonel who had been on the mission, with adhesive across his brow (he had received just a scratch from the flak), was sitting tense and drawn at his desk. In front of him was the dispatch telling of the Boeing strike in Seattle. It was not a serious matter; the men were not out long. Lt.-Col. Wade turned to me and said, "That, sir, is the black damp of death on this wing. If the men at home would see not seven ships down, but seventy men, every man irreplaceable, it would be different, I think."

A ground sergeant came in presently and stood at the desk. Until I die I shall remember him. He was crying like a hurt child. He said, "Sir, I have two brothers in the Boeing works in Seattle. They wouldn't do that to us; they don't understand. They are not to blame."

The boy who was crying at his commander's desk defended his brothers who did not understand!

There is vastly more than first appears behind a strike, gentlemen. When I was a little boy in Cambria, Pennsylvania, I saw bodies carried out from the mouth of the J. C. Stinman mine. There had been an explosion—black damp; and ever since that day I have seen the red in the black of the coal.

I don't believe any man has ever been paid too much to bring coal out of the depths of the earth. But men out there now can accept no reason for a strike anywhere because, you see, it is life and death for them and for the cause they represent, and that, to them, is all that matters. No slowdowns, no strikes. That applies to all of us. When word comes of inferior materials manufactured at home they stand literally aghast. They can't understand it. And may I say this: I do not believe there is a man in any foxhole—I do not believe there is a man in any Flying Fortress—I do not believe there is a man in any submarine who does not believe that we should establish on the home front the universal service principle.

To me the question, will it prevent strikes? is absolutely incidental. That issue will be decided over here. The principle stands. We are all in; if freedom wins, all are free; and if freedom loses, then all have lost.

Strangely enough, the text of the preacher has in our time been fulfilled. We cannot win with freedom in this war without winning freedom at least for our foes, as well as for our friends. For I tell you that never again can the United States of America enjoy the justified hope of an ordered freedom with the justified hope that war itself shall come not to our children's children unless the last man of the last country enjoys that hope—for it is indeed a new kind of world.

We live too close together; the most remote tribe is now in our back yard.

I have been interested in our bond campaign in Philadelphia. I have been serving, representing my particular faith on the committee, and have been calling on some of my brethren. One of these men told me that he was not interested in the proposition because he did not believe in war, wouldn't touch it, and wouldn't run the risk of touching it.

"Well," I said, "that is all right. But aren't you in favor of feeding the men who are over there? Won't you buy a bond and be interested in buying a bond to feed the men who are over there? Bonds buy bread as well as bullets."

I told him that last April, after Rommel's break through in Tunisia—and I was in North Africa and in Tunisia at the time—there were nearly 80 hours when the men of the 34th Division in advance positions had only tomato juice and "iron bread," hardtack, and they didn't complain, because they knew that other men were dying to open the roads to get the food to them. So I said to this man, "Don't you think that you would be willing to buy bonds to get food to the men out there? You see, it is like that."

We pay taxes, and I submit to you tonight that by every sacred test, the last man, whatever his convictions may have been before the theory became a fact, and the battle is joined, the last man at home has responsibility before God and man equal with the responsibility of the man in the Flying Fortress and in the foxhole.

I have a lad, the second officer on a ship somewhere in the Southern Pacific, perhaps covering landings in the Marshalls now. And another at the controls of a great bomber somewhere, if he remains alive tonight. They are there and I am here. But before the Father of us all, I feed the shells into their cannon and the gas into their tanks, and morally I am responsible with them, though they eventually have blood upon their hands perhaps.

There is only one way to stay out of war, and that is to keep it out of the world and away from every human front. That is the realism of this war.

There is something more that I would say, for tonight I have a sense of mission. I would speak, though faintly, for those who are not present and are not able to articulate their sentiments.

I do not believe there is a man in a foxhole nor in a Flying Fortress nor in a home camp who does not feel that this great, free America should make it possible for every man in uniform to cast his ballot. There is no state right, there is no

party right, there are no other rights that should deprive the man in uniform of his voting rights or that should jeopardize his voting rights. I do not think the man in uniform would have thought about it at all if the question had not been raised. When the election took place in Philadelphia this fall I was in a Base Hospital on the Ledo Road, out in front of Assam, one of the largest hospitals in the Army—2500 beds. When I came off the trail into that ward I looked up into the eyes of a girl from my own congregation. It was ten days after the election before it occurred to me that there had been an election in Philadelphia. I was deeply interested in that election. Then I asked the great surgeon, Dr. Rovdin of Philadelphia, whether he knew how the election had gone, and he said, "What election?"

I said, "Philadelphia"!

It was another ten days before we found out. They had not been thinking about elections. But now that the question has been raised, believe me, they are thinking. I had a letter from a lad named Joseph Engelhart, an office boy, a graduate of Girard College. He wrote and said, "You must have brushed me when you passed at headquarters, for I was standing post right there." He said, "I cried when I found you had been so close." But you do not easily recognize each other. That was the day that Faid Pass was retaken. Then he said something more. He described the battalion left on the mountain when Rommel broke through. That first night, you may recall, we lost a battalion and a half, as prisoners of war. But this battalion decided to make the effort to get through and they went through eight miles of enemy lines in order to rejoin their division. He said, "On the last day on the mountain (and may this be my tribute to the chaplains in this war) we could not go to church; there could be no services. We were in our foxholes and we were strafed all day and there was an icy rain. Then the chaplain carried marked testaments to us in the foxholes and told us to read the verses and pass them to the next foxhole, and so the church came out to us. That night we started back. The chaplains stayed on the mountain with our wounded and with the German wounded." But those words, "the church came out to us," that is the challenge to the church of your faith and mine today—"the church came out to us."

I found religion on all these fronts, but it did not follow the usual patterns. There is mighty little time for men to sing hymns in front of an altar, but I did find religion pure and undefiled—often obscured by heavy oaths, to be sure, and obscenities and sex—so that if you heard only the surface sounds you might reach the conclusion that the army is pagan, but you must listen, as I listened, and hear the deeper note of character beneath—religion pure and undefiled. The Major with tubercular kidneys, going home to die, rubbing the backs of men acutely ill; the driver on the mail truck on the Ledo Road who had a cough that sounded like pneumonia but who drove twelve miles out of his way to get a lost kid from Georgia back to his outfit; the nurse at Marker 31, hard on the boundary of Burma, who was pinning a curtain on her window to make it look like home to homesick men—religion pure and undefiled.

I could not tell you what they think, for who knows what a man thinks? But they think and they act. It was in a Base Hospital one Monday morning that Brigadier-General Chieves, Chief of Staff to General Royce, gave me the high privilege of pinning on the ribbons while he read the citations—22 men from the beaches of Salerno and from Italy. That hospital was a poignant sight. Men with their legs toward the ceiling, held by weights in that position; men between sandbags; men terribly burned; silent men on beds, their eyes covered—eyes that would not open ever again. The General read the citations and I pinned on the ribbons. When we came through the entrance and were leaving, the registrar, Medical Major Glen Williams, said, "General, there is an unannounced item on the program, if you are willing." The General said, "All right, what is it?" The Major said, "The men want to sing."

There were three instruments—a banjo, a violin, and a mouth organ—and so they sang. The wounded from Salerno and from Italy, the maimed and the blind, sang "God Bless America."

> "God bless America, land that I love—
> Stand beside her and guide her
> Through the night with a light from above."

I wish that every man in America could have stood as I stood there to hear them sing. I didn't sing. I had not earned the right to sing in that choir.

They are fighting to get home. More often than in any other phrase do they express it thus—fighting to get home.

But there is vastly more than that in it. There isn't an isolationist in uniform whom I have met. They are not imperialists. They do not want a single inch of the ground their feet have trod. But one thing they know: that since we could not stay out of the war, we are fools to try to stay out of the peace.

They are realists; they are fighting to get home. But what home? They are fighting with the high purpose that they shall have their part in winning a decent peace. They believe that winning the war and winning the peace are one and indivisible, and that to win the chance to build a decent world we must first of all win the war. The peacemakers of this night, men and women, are the men in the camps—your men and mine, and the men on the sea and on the land and in the air who are fighting to help win the war—that is the realism of the war.

I wish that I might share with you certain Chinese impressions because when our men come back they are likely to be sadly disillusioned. The Chinese situation is significantly more than the visit of the radiant Madame Chiang Kai Shek. Some things are difficult to understand. I had three days with a Colonel, our field artillery expert, who is with the advance Chinese combat divisions on the Burma frontier on the China side. He was recovering from four wounds and was just out of the hospital. Any one of the wounds might have been fatal, and they were received from Chinese bandits. He was in command of a small convoy of three trucks, five other officers and nine enlisted men, on his way to the front, 90 miles out of Kungming, when, rounding a curve, they found

themselves in the midst of bandits who were looting three Chinese trucks. Fire opened at once. All the officers were wounded, the Colonel seriously. They got two of the trucks back to the Chinese town at the rear, just around the curve. The Colonel said, "It is tough to be out here fighting in a common cause and then to be shot up like that. But we need to remember that China is now passing through what was our frontier period of half a century ago. We need to remember that when Chiang Kai Shek first faced the Japanese he controlled only seven provinces of China and had civil wars of one size or another confronting him in every other province; that he stood between the extreme left and the extreme right. You must remember that," he said.

We must not forget that there was a time when in our own great Western territories and states, ranges were rustled and burned, communities were terrorized, stage coaches were robbed. Then came the Vigilantes and the United States marshals, and gradually law and order emerged. Well, that is China of today. But let us never forget that this great leader, incorruptible, has been able to stand through seven long years, refusing to sell out to the highest bidder when Japan, to save face now, would retire with scarcely a memory of what she first asked for.

Through the complexities of these war days, the courage of China through these seven years shines like a star resplendent on the field of international affairs.

There are a number of things that stand clear for us, that reach us tonight in this great room. But, above all things else—and with that I am sure I should make way for the program that is to follow—is this compulsion to national unity—unity, not uniformity. We be Catholic and Protestant and Jew, we are of all faiths and all colors. In this great national stream there are the blendings of all the racial currents of the earth, but it was our great one who said that "united we stand, divided we fall." This is the test at last, not of our ability to meet the foreign invader, but of our ability to face and meet ourselves. I do not finally fear today any foe that might embark from foreign shores to seek us out and do us hurt. The only thing that could destroy us would be this thing, this dry rot from within. Out there there is unity. The tremendous significance of the task itself is ever before men, but here it seems more difficult for us to understand, to understand each other.

I have been with the First Division in the other war and with the Twenty-sixth Regiment, so I was particularly anxious to see the First Division in this war. I found it 12 miles in front of El Guettar on the Gafsa Road. It was the day the great tank battle opened. The tanks came down between the 16th and the 26th, moved beyond the guns and fanned out left and right across the desert. That night advance patrols from the First Division and the Ninth met the British Eighth Army, Montgomery's desert army. Until the end of time there will be discussions and debates as to who it was, and the exact spot! Naturally, I was anxious to see my successor, after 25 years, and I found him, Chaplain Chase, who had been cited, decorated, and promoted on the field of battle.

Teddy Roosevelt told a story about him that Chaplain Chase says is apocryphal, but it is a good story and I brought it back, much to the confusion of the Chaplain. He was called "young Teddy" 25 years ago. He is 25 years older now. I found him the second in command of the First Division at headquarters in a little oasis, Major-General Terry Allen in command. I had an afternoon and a night there and we talked about other times. I had seen him as a second lieutenant and a first lieutenant and a captain and a major and a lieutenant-colonel and then colonel. Now as a brigadier-general he was back with his old organization again. I told him that I was looking for Chase, and he said, "That man is absolutely a fool," and he described the days when Rommel was moving through the lines of the 34th in the north and the First Division was outflanked. He said, "We were moving back, getting our vehicles out, moving the 77th Evacuation Hospital. We were doing pretty well, and the orders were for men to get out of their vehicles when the strafing planes came over, for them to get into the fields and then, when the raids were over, to get back into their vehicles as quickly as possible. We had things well in hand. Four o'clock in the afternoon I heard a jeep struggling up the road. I rushed out and threw up my hand. All other vehicles had stopped except this jeep that was struggling up the road. I jumped on the running board. It was the Chaplain. He had his foot right down to the board. I called to him but he did not look up. He said, 'Sir, I have waited six months for this jeep and I am not leaving it behind now.' Then he motioned to the rear, and I saw that he had two wounded men in the rear of the jeep, and I got off the running board."

Well, I found Chaplain Chase at the graveyard behind corps headquarters. With him I found two other men, MacEvoy, the priest who for eight years was pastor of the Floral Park Parish on Long Island, and Stone, the Jew. I found them burying their dead, eleven white bags by the road—Arabs digging in the sun-baked sand, going down less than four feet. That was deep enough. When the graves were ready we lifted the sacred burdens and placed them in their last resting place. Then Stone read above his Jewish dead, and MacEvoy read above his Catholic dead, and Chase read above his Protestant dead, but they read from the same Book and they prayed to the same God.

It is like that, men and women, in this war. It is a unity that transcends differences. It is a unity that strengthens every worthy individual loyalty. The Catholic is a better Catholic, and the Jew is a better Jew, and the Protestant is a better Protestant for being an American—we are better for being *Americans all* in a time like this.

The 2nd of February, one year ago tonight, the Dorchester, a small cargo transport, was moving steadily through iceberg-infested and submarine-crowded waters—one year ago tonight. At 1:15 the torpedo struck, almost amidships, and silenced the engines. The ship listed and in less than 25 minutes went down. The story runs that there were on board that ship four chap-

lains—a Catholic, a Jew, and two Protestants. They were friends—intimate friends. They had on their life belts. They did their best to quiet panic. Six hundred and seventy-eight men of the 904 on board the Dorchester died that night. Then, when there was nothing else to do, these four men took their life-belts and forced them upon four enlisted men, and gave away their chance to live.

I went out to Valley Forge in the spring after my return from my first overseas visit of the past year to talk to Grady Clark, an engineer of the Dorchester. He told me what happened on the deck and how, as he slid under the rail and swam a bit away, he saw the prow come up high and the ship slide under. He said, "Side by side, the four chaplains stood on the deck, praying still for the men who were struggling in the water."

One of those men was Washington, the priest; another was Goode, the Jew; another was Fox, the Methodist, and the fourth, the youngest, was our son. This is the anniversary that I am celebrating. I have come here tonight to say to you that the only justification for my presence is the tremendous sense of privilege that I feel, as a Protestant clergyman, in adding my word to the high calling of American citizenship and to this unity in which we shall be free, in which we shall find the answers, in which we shall preserve and perfect liberty, not only for ourselves and for our children, but for all who shall come after us.

"O Captain, my Captain—
The night is black with thunder.
The ship is tossing in the waves' wild will.
The foaming whitecaps hiss and slip from under.
The mighty engine's throbbing heart is still.

"Where are we drifting in this night of peril?
Hysteric pilots wrangle at the wheel.
With rudder gone into the glooming terror,
The great ship rushes on uneven keel!

"'O, ye of little faith, am I not able'—
I hear my Captain's answer brave and strong—
'When every anchor slips her faithless cable
To guide the ship that I have kept so long?'

"The little pilots at each other railing
Soon fall asleep, and all their strife forget.
But I, who set the fleets of time to sailing,
Have this great nation in My guidance yet."

God bless you, every one.

PRES. DOWNS VISITS CHAPTERS

Pres. S. H. Downs, Kalamazoo, Mich., is scheduled to visit the western chapters during the month of April and his itinerary includes: Minnesota on the 3rd, Manitoba the 5th, Pacific Northwest the 10th, Oregon the 11th, Golden Gate the 13th, and Southern California on the 17th. He will also visit with membership groups at Salt Lake City on April 20, and at Denver on April 22.

President Downs talked to chapters at Toronto on March 13, Montreal on March 14, Boston on March 16 and at Bridgeport, Conn., on March 17, on the subject of *Flow of Air and Gas in Various Systems.*

G. W. AKERS NOW CAPTAIN IN NAVY

Capt. George W. Akers was detached from sea duty and ordered to the Navy Yard at Charleston, S. C., upon his promotion from Commander to Captain. He has been on active duty with the Navy since 1941, on leave of absence from George W. Akers Co., Detroit, Mich., as secretary-treasurer of the company.

CHAPTER DELEGATES' MEETING

A meeting of the Chapter Delegates convened at the Hotel Pennsylvania, on Tuesday, February 1, 1944, at 4:30 p. m., in Conference Room 3 with J. F. Collins, Jr., Pittsburgh, presiding. Pres. M. F. Blankin, Pres.-Elect S. H. Downs, and A. V. Hutchinson, Secretary of the Society, were in attendance by invitation.

C. E. Price, Chicago, reported for the Chapter Development Committee, stressing the point that Chapters should increase their membership from Society members.

The Speakers' Bureau was then discussed by delegates from several of the chapters, followed by a suggestion that a questionnaire be sent to each chapter so that it could forward any suggestions on planning and conducting meetings, which would later be made available in the form of a news letter.

Mr. Hutchinson announced the various itineraries for President-Elect Downs, First Vice-Pres. C.-E. A. Winslow and Second Vice-Pres. A. J. Offner for the coming year.

The new record book was then discussed, and after a motion, properly seconded, it was voted that Chapter application form be printed on reverse of Kardex to give complete record on all members.

The representatives from Delta, Michigan, Minnesota and St. Louis Chapters announced that each had gone on record as opposing the Kilgore Bill, which was brought up at the meeting.

Following a discussion on the operation of the Chapter Relations Committee, it was moved and seconded that the Chairman appoint a Committee of Chapter Delegates to prepare the By-Law which would provide for the Chapter Delegates to be included in the By-Laws of the Society and have it available for presentation at the Delegates Meeting in June.

The Delegates who answered the roll call and visiting chapter members were as follows: I. B. Kagey and T. T. Tucker, Atlanta; Amos Hard, H. E. Sproull and G. V. Sutfin, Cincinnati; T. J. Converse, Connecticut; John S. Burke, Delta; R. A. Folsom, Golden Gate; C. E. Price, Illinois; W. C. Bevington, Indiana; C. W. Helstrom, Iowa; D. M. Allen, Kansas City; F. L. Chester, Manitoba; R. T. Kern and E. G. Carrier, Massachusetts; S. S. Sanford, Michigan; F. W. Legler, Minnesota; T. H. Worthington, Montreal; B. G. Peterson, Nebraska; R. A. Wasson and C. S. Koehler, New York; Arvin Page, North Carolina; G. A. Linskie, North Texas; G. B. Priester, Northern Ohio; E. T. P. Ellingson, Oklahoma; H. R. Roth, Ontario; E. C. Willey, Oregon; M. N. Musgrave, Pacific Northwest; A. C. Caldwell, Philadelphia; T. F. Rockwell and L. S. Maehling, Pittsburgh; C. F. Boester, St. Louis; J. A. Walsh and C. A. McKinney, South Texas; Leo Hungerford, Southern California; Lt. S. L. Gregg and F. A. Leser, Washington, D. C.; C. H. Pesterfield, Western Michigan; S. M. Quackenbush, Western New York; and Ernest Szekely, Wisconsin.

Revised Code Procedure for ASHVE

A REVISED code procedure developed by the Standards Committee of the ASHVE was approved by the Society Council on January 30.

The new procedure enables the Standards Committee to take all steps which are necessary to expedite the progress of any code through the various stages leading up to final approval. Provision is made for examination and criticism of tentative codes during a 60-day period in order that the code committee may have the benefit of suggestions from the members before completing the final draft of the code.

The various steps to be taken in preparation of new codes or in considering codes submitted to the Society for endorsement are shown in

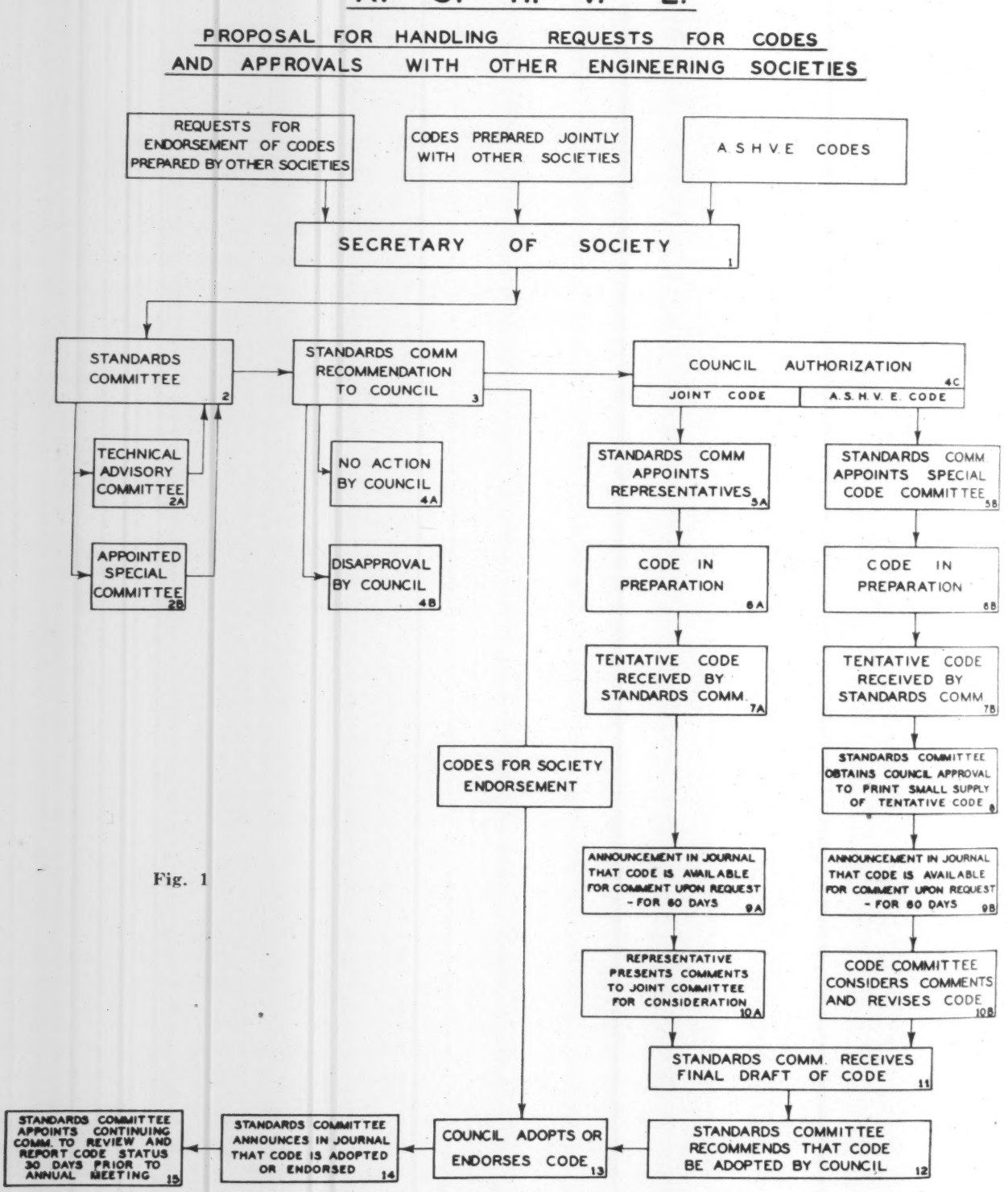
A. S. H. V. E.
PROPOSAL FOR HANDLING REQUESTS FOR CODES AND APPROVALS WITH OTHER ENGINEERING SOCIETIES
REQUESTS FOR ENDORSEMENT OF CODES PREPARED BY OTHER SOCIETIES
CODES PREPARED JOINTLY WITH OTHER SOCIETIES
A S H V E CODES
SECRETARY OF SOCIETY 1
STANDARDS COMMITTEE 2
STANDARDS COMM RECOMMENDATION TO COUNCIL 3
COUNCIL AUTHORIZATION 4C
JOINT CODE
A.S.H.V.E. CODE
TECHNICAL ADVISORY COMMITTEE 2A
APPOINTED SPECIAL COMMITTEE 2B
NO ACTION BY COUNCIL 4A
DISAPPROVAL BY COUNCIL 4B
STANDARDS COMM APPOINTS REPRESENTATIVES 5A
STANDARDS COMM. APPOINTS SPECIAL CODE COMMITTEE 5B
CODE IN PREPARATION 6A
CODE IN PREPARATION 6B
TENTATIVE CODE RECEIVED BY STANDARDS COMM. 7A
TENTATIVE CODE RECEIVED BY STANDARDS COMM 7B
CODES FOR SOCIETY ENDORSEMENT
STANDARDS COMMITTEE OBTAINS COUNCIL APPROVAL TO PRINT SMALL SUPPLY OF TENTATIVE CODE 8
ANNOUNCEMENT IN JOURNAL THAT CODE IS AVAILABLE FOR COMMENT UPON REQUEST - FOR 60 DAYS 9A
ANNOUNCEMENT IN JOURNAL THAT CODE IS AVAILABLE FOR COMMENT UPON REQUEST - FOR 60 DAYS 9B
REPRESENTATIVE PRESENTS COMMENTS TO JOINT COMMITTEE FOR CONSIDERATION 10A
CODE COMMITTEE CONSIDERS COMMENTS AND REVISES CODE 10B
STANDARDS COMM. RECEIVES FINAL DRAFT OF CODE 11
STANDARDS COMMITTEE RECOMMENDS THAT CODE BE ADOPTED BY COUNCIL 12
COUNCIL ADOPTS OR ENDORSES CODE 13
STANDARDS COMMITTEE ANNOUNCES IN JOURNAL THAT CODE IS ADOPTED OR ENDORSED 14
STANDARDS COMMITTEE APPOINTS CONTINUING COMM. TO REVIEW AND REPORT CODE STATUS 30 DAYS PRIOR TO ANNUAL MEETING 15

Fig. 1

SEMI-ANNUAL MEETING AT GRAND RAPIDS

June 19-20, 1944

The Council has accepted the invitation of the Western Michigan Chapter to hold the Semi-Annual Meeting 1944 in Grand Rapids, and the meeting dates selected are June 19 and 20.

C. H. Pesterfield, president of the Chapter, has announced the appointment of T. D. Stafford as General Chairman of the Committee on Arrangements. The organization meeting of the Committee on Arrangements was held on March 4, and plans for the welcoming and entertainment of the visiting members were discussed.

The headquarters for the meeting will be at the Pantlind Hotel. Complete details for the technical program will be published in the May Journal.

the chart. Numbers have been assigned to the various stages of progress for convenient reference to the status of codes when reports of progress are to be made.

The various stages shown in chart are as follows:

All requests for, *(a)* Society endorsement of a code prepared by another organization, *(b)* Society participation in a code to be prepared jointly by ASHVE and other organizations, *(c)* Society preparation of a code, shall be referred to the Secretary of the Society.

Stage 1: The Secretary shall refer the request to the Standards Committee.

Stage 2: The Standards Committee shall consider the request and may refer it for advice to an existing Research Technical Advisory Committee (Stage 2A) or may appoint a special committee (Stage 2B) for the purpose.

Stage 3: The Standards Committee shall recommend to the Council a proposed action to be taken with regard to the original request. The Secretary shall advise the originator (of the request) regarding the action taken by the Council.

Stage 4: Upon authorization by the Council the Standards Committee shall undertake the preparation of, or participation in preparation of, the proposed code.[1]

Stage 5: The Standards Committee shall appoint representatives for joint committees (Stage 5A) or shall appoint a special code committee, and its chairman (Stage 5B), and shall issue written instructions to the representatives or committee members concerning the scope of the work to be undertaken.

Stage 6: The Standards Committee shall keep informed regarding the progress made by the code committee.

Stage 7: The Standards Committee shall receive the tentative code prepared by the joint code or special code committee (Stage 7A or 7B).

Stage 8: The Standards Committee shall recommend to the Council the preparation of a limited supply of copies of the tentative code for the purpose of obtaining criticism.

Stage 9: The Standards Committee shall announce in the Society Journal that the code is available for 60 days to those who request it for purpose of comment or criticism.

Stage 10: The Standards Committee shall refer the comments received during the 60-day period either to the joint code representative who shall present the comments to the joint code committee (Stage 10A) or to the code committee (Stage 10B) for consideration.

Stage 11: The Standards Committee shall receive the final draft of the code.

Stage 12: The Standards Committee shall recommend Council action regarding adoption of the code.

Stage 13: Upon approval by the Council, *(a)* endorsement shall be given to a code prepared by another organization, or *(b)* a joint code shall be adopted as a Society Code, or *(c)* a code prepared by a special committee shall be adopted as a Society code.

Stage 14: The Standards Committee shall announce the endorsement or adoption of the code in the next issue of the Society Journal.

Stage 15: The Standards Committee shall discharge the committee or representative and shall appoint a continuing committee which shall report the status of the code, 30 days prior to the Annual Meeting of the Society.

[1]Completed codes submitted for endorsement of the Society when approved by the Council shall not be required to pass through Stages 5 to 12, inclusive.

Revision of Codes

The revision of codes shall proceed from Stage 2 to Stage 13 in the same manner as the preparation of a new code.

In the Spirit of the Gay 90's at the Old Timers Party at the 50th Annual Meeting in New York

SUMMARY OF LOCAL CHAPTER MEETINGS

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Cincinnati	Feb. 8	Costs of Operation of Refrigeration Used for Air Conditioning	R. E. Cherne, Carrier Corp., Cincinnati Office	Amos Hard reported on 50th Annual Meeting of Society	20	0.40
Delta	Feb. 8	Utilization of Natural Gas as a Fuel in Heating Boilers	L. S. Reagan, Vice-Pres., Webster Engrg. Co., Tulsa, Okla.	J. S. Burke reported on Chapter Delegates Meeting in New York. Members ASME Section were guests of Delta	69	0.53
Illinois	Feb. 14	Heating and Ventilating on Ships	J. H. Clarke, U. S. Maritime Commission	A. O. May reported on 50th Annual Meeting	93	0.64
		National Fuel Efficiency Program	John Howatt, Chm., Engrg. Adv. Committee for Fuel Conservation	War Production Board Clinic discussed by Messrs. Price, Lewis and Brooke		
Indiana	Jan. 28	Radiant Heating	C. A. Hawk, Jr., A. M. Byers Co., Pittsburgh	W. C. Bevington reported on Chapter Membership	68	0.75
Kansas City	Feb. 28	Pick Plan for the Missouri River	R. E. M. Des Islets, Corps of Engrs., U. S. Army	E. K. Campbell reported on 50th Annual Meeting	36	0.64
Massachusetts	Feb. 15	Conduit Air Distributing, Heating and Cooling Systems	William McGrath	By-Laws changed to install new officers in May	39	0.67
Michigan	Feb. 14	Recent Trip to Yucatan (illustrated with slides in natural color)	T. S. Bindshedler	Films loaned by U. S. Navy entitled, Tarawa and Life and Death of the U. S. S. Hornet	65	0.66
		Fuel Efficiency Program	G. D. Winans			
Minnesota	Feb. 14	Report on 50th Annual Meeting	F. W. Legler	Sound movie, "Target for Tonight"	37	0.54
Montreal	Feb. 21	Electronic Applications	L. E. Butters	Film on television, "Sight Seeing at Home"	31	0.50
		Activities at 50th Annual Meeting in New York	Thomas Worthington			
Nebraska	Feb. 8	Report on 50th Annual Meeting in New York	B. G. Peterson, Chapter Delegate	Committee reports and routine Chapter business	14	0.64

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
New York	Feb. 21	Electronics and Air Conditioning	C. P. Bernhardt, Westinghouse Elec. and Mfg. Co.	Report by A. J. Offner, Gen. Chm. 50th Annual Meeting	94	0.52
		Motion Pictures and Slides shown on subject matter	J. E. Haines, Minneapolis-Honeywell	Past Pres. gift to H. H. Bond by C. S. Pabst Report of Nominating Committee		
Northern Ohio	Feb. 14	Packaged Heat	David Jones, Vapor Car Heating Co.	G. B. Priester reported on 50th Annual Meeting	55	0.72
Ontario	Feb. 7	Fluorescent Lighting	D. C. Borden	Pres. W. C. Kelly and V. J. Jenkinson reported on Annual Meeting	67	0.48
Oregon	Feb. 10	Moses Plan for Portland	W. A. Bowes	Nominees announced for next year's officers	20	0.42
Pacific Northwest	Feb. 8	Report on 50th Annual Meeting in New York	E. O. Eastwood, Seattle, Wash.	R. E. LeRiche reported on Program	21	0.49
Pittsburgh	Feb. 14	Activities of the Society in Wartime	M. F. Blankin, Past Pres. of ASHVE	T. F. Rockwell reported on Chapter Delegates Meeting in New York	27	0.41
St. Louis	Feb. 3	Temperature and Humidity Control in Growth and Manufacture of Penicillin	L. T. Avery, Cleveland, Ohio	Messrs. Boester and Myers reported on 50th Annual Meeting in New York	39	0.40
Southern California	Feb. 9	State Legislation and Post War Construction	Earl S. Anderson, Mgr., Construction Industries Dept., L. A. Chamber of Commerce		27	0.28
Washington, D. C.	Feb. 9	Recent Trip to Europe	Marcus W. Childs, author, correspondent and columnist	Lt. S. L. Gregg reported on Annual Meeting	65	0.34
		Hot Water Boiler Safety	E. N. McDonnell and N. W. Swanson, Chicago	Lt. P. H. Loughran, recently returned from duty in Australia, exchanged greetings		

*The attendance ratios shown represent the meeting attendance divided by the Chapter membership. These will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by other local chapters and may be helpful in deciding on subjects for other chapter meetings.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 58 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by April 15, 1944, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ANDERSON, HARVEY E., Secy., Narowetz Heating & Ventilating Co., Chicago, Ill.	W. A. Kuechenberg E. P. Heckel	H. J. Prebensen J. J. Philippi
BAIN, LAWRENCE F., Outside Supt., Narowetz Heating & Ventilating Co., Chicago, Ill.	L. L. Narowetz, Jr. W. A. Kuechenberg	J. S. Kearney E. M. Mittendorff
BAKER, JAMES, Partner, Ross & Greig Registered, Montreal, Que., Canada	John Colford F. A. Hamlet	Leo Garneau T. H. Worthington
BAKKO, REUBEN, Refrig. and Air Cond., U. S. Navy, San Francisco, Calif.	*Adam Hulvey *C. C. F. Kam	
BAND, JACK, Directorate of Naval Construction, Ottawa, Ont., Canada	F. R. Bishop E. K. Campbell	W. A. Russell R. P. Campbell
BAZILLE, CLARENCE H., Mgr., Htg. Dept., Harry Lee Plumbing & Heating, Burlingame, Calif.	N. H. Peterson H. V. Hickman	K. O. Alexander C. L. Peterson
BEAGHEN, GEORGE W., Field Engr., American Blower Corp., New York, N. Y.	H. E. Barth Arthur Ritter	D. L. Taze O. O. Oaks
BELL, JOHN A., Warrant Officer First Class, Royal Canadian Air Force, Winnipeg, Man., Canada	D. G. Saunders Einar Anderson	F. L. Chester D. S. Swain
BUCHANAN, WALTER P., N. E. Mgr., B. F. Sturtevant Co., Boston, Mass.	A. C. Bartlett R. L. Lincoln	J. W. Brinton E. L. Blair
BYERLEY, FRANCIS A., 3rd, Engr., Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.	S. E. Fenstermaker, Jr. G. B. Supple	C. H. Hagedon G. O. Jackson
CAMBRIDGE, W. A., Pres., Reid & Cambridge, Ltd., Westmount, Que., Canada	John Colford F. A. Hamlet	Leo Garneau T. H. Worthington
CAMERON, JOSEPH A., Jr., Mgr., N. Y. Office, The Marley Co., Inc., Kansas City 15, Kans.	A. C. Buensod C. S. Pabst	H. J. Ryan H. H. Bond
CHERNE, ANTHONY L., Gen. Mgr., Reuben L. Anderson Co., Phoenix, Ariz.	*W. C. Hedrick *R. M. Knox	*R. L. Anderson *A. W. Kerr
CHRISTESEN, MARTIN C., Field Engr., Hoffman Specialty Co., New York, N. Y.	F. H. Gaylord C. W. Stewart	Ferdinand Jehle E. N. Sanbern
CLARK, ROBERT J., Plant Engr., Jack & Heintz, Inc., Peninsula, Ohio	P. D. Gayman Dennis Boggs	G. B. Priester L. T. Avery
CLOSE, JAMES W., Pres., Sheet-Metal-Workers-Union, Chicago, Ill.	L. L. Narowetz, Jr. W. A. Kuechenberg	J. S. Kearney E. M. Mittendorff
DAHLSTROM, J. A., Head of Furnace Development Div., Perfection Stove Co., Cleveland, Ohio	J. F. Platz H. F. Curtis	R. J. Cummings G. L. Tuve
DIRECTOR, ISADORE, Mech. Engr., Public Works, Philadelphia Navy Yard, Philadelphia, Pa.	M. E. Barnard F. N. Keeling	R. H. Smiles R. F. Hunger
EDMONDSON, JOHN V., Asst. Mgr., Dallas Branch, Crane Co., Dallas, Tex.	C. R. Gardner E. T. Gessell	W. A. Russell J. A. Ray
ENGSKOW, JOHN C., Htg. Engr., Baker Manufacturing Co., Omaha, Nebr.	B. G. Peterson W. R. White	D. E. McCulley Verne Simmonds
GOODMAN, CARL L., Post Engr., Camp Gruber, Okla.	R. G. Dolan E. W. Gray	E. F. Dawson E. T. P. Ellingson
GOULDBOURNE, THOMAS H., Dir., Sales, The Standard and Pochin Bros., Ltd., Leicester, England	R. H. Davies *W. H. Rowlett	*William Pittman *E. O. Stubbings
GRATIOT, JULES D., Sales Mgr., Air-Maze Corp., Cleveland, Ohio	L. E. Slawson C. S. Anderson	W. O. Stewart Leo Hungerford
HAWK, CHARLES A., Jr., Mgr., Engrg. Service Dept., A. M. Byers Co., Clark Bldg., Pittsburgh, Pa.	D. W. Loucks T. F. Rockwell	A. F. Metzger C. M. Humphreys

HILL, N. E., Designing Engr., The L. J. Mueller Furnace Co., Milwaukee, Wis.	F. J. Nunlist, Jr. H. P. Mueller	R. W. Weekes N. M. Blanchard
HORN, ARTEMUS J., Research and Designing Engr., Perfection Stove Co., Cleveland, Ohio	J. F. Platz H. F. Curtis	R. J. Cummings G. L. Tuve
ILOVITCH, ELI L., Asst. Engr., Air Conditioning Engineering Co., Ltd., Montreal, Que., Canada	S. S. Colle T. H. Worthington	F. A. Hamlet Leo Garneau
JESSUP, F. JUDSON, JR., Htg. and Air Cond. Repr., Public Service Electric & Gas Co., Englewood, N. J.	J. P. Leinroth H. P. Morehouse	R. F. Kershaw S. J. Carlson
KINGSLAND, GEORGE M., Zone Supvr., Minneapolis-Honeywell Regulator Co., Cleveland, Ohic	Herman Seelbach, Jr. S. W. Strouse	M. C. Beman B. C. Candee
KNIGHT, FRANK B., Plant Engr., Crosley Corp., Cincinnati, Ohio	G. V. Sutfin H. E. Sproull	L. L. Kuempel O. W. Motz
KOTZEBUE, R. W., 1st Lt., Corps of Engineers; Head Equipment and Control Unit, Hq. Eighth Service Command, Dallas, Tex. *(Reinstatement and Advancement)*	E. T. Gessell J. A. Ray	W. H. Moler G. E. McClanahan
LYNCH, RODERICK, Vent. Engr., Dutton Asbestos & Supply Co., San Francisco, Calif.	E. C. Fanning C. E. Bentley	R. B. Holland G. M. Simonson
LYNDE, C. J., JR., G. Lorne Wiggs & Co., Montreal, Que., Canada	G. L. Wiggs W. W. Timmins	L. A. Hood J. E. R. Dupuis
MACGREGOR, DUNCAN, Metallurgical Furnace Designer, Railway & Power Engineering Corp., Ltd., Toronto, Ont., Canada	A. J. Strain W. C. Kelly	V. J. Jenkinson W. H. Evans
MCCARL, HARRY E., Utilities Engr., Des Moines Ordnance Plant, Des Moines, Ia.	B. E. Landes F. E. Triggs	D. C. Murphy C. A. Wheeler
MEREDITH, JOHN W., Htg. Engr., U. S. Navy—Boston Yard, Charlestown, Mass.	D. J. Edwards E. G. Carrier	J. W. Brinton T. P. Mandell
MORIN, R. P., in charge of ventilation, Gibbs & Cox, Hoboken, N. J.	M. S. Smith A. C. Buensod	H. L. Janet G. A. Dornheim
NELSON, ARTHUR W., Major, Corps of Engineers; Post Engr., Camp Edwards, Mass. *(Reinstatement and Advancement)*	*A. C. Anderson *G. M. Mathews	*W. E. Adams *W. L. Papp
NORMAN, GEORGE C., Engr., Koithan & Johnson, Newark 2, N. J.	H. S. Johnson H. J. Ryan	Joe Wheeler, Jr. M. F. Rather
NORRIS, WILLIAM P., Assoc. Engr., U. S. District Engineers Office, Galveston, Texas *(Advancement)*	M. A. Disney A. F. Barnes	*W. Z. Lidicker A. J. Natkin
PAUL, DEAN W., Field Engr., Sterling Electric Motors, Inc., Los Angeles 22, Calif.	W. D. Fabling Leo Hungerford	W. O. Stewart J. F. Park
PETERS, WILLIAM S., Partner-Gen. Mgr., A. J. Peters & Son, San Jose 4, Calif.	H. V. Hickman N. H. Peterson	R. C. Cushing C. L. Peterson
PHILLIPS, LEONARD S., Mgr., Commercial Relations, New York Steam Corp., New York, N. Y.	G. D. Winans G. H. Tuttle	E. E. Dubry S. S. Sanford
PORTER, FRANK, Owner, Porter Engineering Co., Silver Spring, Md.	A. B. Devore W. E. Kingswell	F. B. Sale T. H. Urdahl
QUIN, CHARLES C., Branch Mgr., The Powers Regulator Co., Houston, Tex.	F. C. Brandt A. M. Chase, Jr.	A. F. Barnes R. F. Taylor
REINHARDSEN, DANIEL, Dist. Sales Mgr., Spencer Heater Div., Aviation Corp., Williamsport, Pa.	J. E. Axeman M. F. Blankin	A. E. Kriebel C. F. Dietz
SIDBURY, ROY W., Sales Engr., Chase Brass & Copper Co., Waterbury, Conn.	S. R. Osborne P. D. Bemis	*H. B. VanJehn
SNYDER, L. R., Owner, L. R. Snyder Co., Dallas, Tex.	J. A. Ray E. T. Gessell	W. H. Moler A. B. Ulrich, Jr.
STEWART, WESLEY O., Branch Mgr., Johnson Service Co., Los Angeles 31, Calif. *(Advancement)*	Leo Hungerford J. F. Park	Maron Kennedy C. S. Anderson
STOREY, J. H., Pres., John Tweddle, Ltd., Montreal, Que., Canada	F. A. Hamlet Leo Garneau	A. M. Peart J. B. Dykes
TAYLOR, ROBERT B., Repr., Buffalo Forge Co., Albany, N. Y. *(Advancement)*	H. A. Bond C. A. Booth	Roswell Farnham W. R. Heath
THOMPSON, WILLIAM D., Mgr., Industrial Div., Laclede Gas Light Co., St. Louis, Mo.	J. W. Cooper R. H. Kremer	G. W. F. Myers B. C. Simons
TOUPIN, VALERIEN, Htg. Engr., Municipal Buildings Dept., Montreal, Que., Canada	Leo Garneau R. F. Wormley	J. G. Chenevert F. A. Hamlet
WALDO, HARRY J., Mfrs. Repr., Air Devices, Inc., New Orleans 12, La.	G. E. May J. J. Joyce	J. S. Burke L. R. Cressy
WATTERSON, W. B., Adv. Mgr., Air-Maze Corp., Cleveland, Ohio	L. E. Slawson R. H. Cutting	J. P. Jones L. T. Avery
WILLIAMS, O. L., Distr., Bryant Heater Co., Cleveland, Ohio	T. F. Rockwell C. M. Humphreys	E. H. Riesmeyer, Jr. R. B. Stanger
WOODWARD, KENNETH C., Htg. Engr., Chase Brass & Copper Co., Inc., Waterbury, Conn.	*H. B. Van Jehn G. F. Nieske	*Lorenzo Hamilton S. R. Osborne
YULA, RALPH W., Chemical Engr. (Project), Lederle Laboratories, Inc., Pearl River, N. Y.	E. H. Morgan, Jr. E. J. Ritchie	R. W. Cumming B. H. Lee

*Non-Member.